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ORIGINAL ARTICLES.

I.—On a New British Isopod (*Cyclosphæroma trilobatum*) from the Great Oolite of Northampton.

By Henry Woodward, LL.D., F.R.S., F.G.S.

(PLATE XV.)

MR. THOMAS JESSON, B.A., F.G.S., of Great Houghton House, Northampton, was lately so fortunate as to discover in the Great Oolite of that county, a new and most interesting example of an Isopodous Crustacean, which, by his kindness, I am permitted to figure and record in the Geological Magazine.

The last-described British Isopod was obtained from the Upper Greensand of Cambridge, and made known by Mr. James Carter, F.G.S., in this Magazine.[1] In his paper Mr. Carter gives a careful résumé of our knowledge of the species of this order which have hitherto been found in a fossil state, both British and Foreign, and it will therefore be sufficient, for our present purpose, to refer the reader to that admirable summary.

The specimen, which forms the subject of this article, was found imbedded in compact white crystalline limestone; only the upper surface of the cephalon, the body-segments and the telson being exposed (see Plate XV. Fig. 1*a*). About one-half of the fossil, consisting of the cephalon and the anterior thoracic segments, has the outer crust or shell preserved; the posterior segments, the abdomen and telson are seen as a sharp cast of the animal in the fine calcareous matrix. The margins of the cephalon, the segments and telson have suffered considerably in the process of removal from the parent-rock in which they had been enclosed, thus leaving much to be desiderated before we can obtain a complete and satisfactory knowledge of the fossil.

The epistomial plate, together with traces of the antennules and antennæ, can be made out in front of the cephalon (Pl. XV. Fig. 1*c*); also the basal portion of the left uropodite on the side of the telson.

A careful comparison of Mr. Jesson's specimen with several recent and fossil forms, has satisfied me that it should be placed in the Isopoda, and in the Family Sphæromidæ, of which I here subjoin a brief diagnosis, summarized from Messrs. Spence Bate and J. O. Westwood's excellent work.[2]

[1] See Geol. Mag. 1889, pp. 193–196, Pl. VI. Figs. 1–7.

[2] A History of the British Sessile-eyed Crustacea, by C. Spence Bate and J. O. Westwood, 1868, in 2 vols.; vol. ii. p. 398, etc.

Sphæromidæ.—Body short, broad, and very convex; often contractile into a ball; foot-jaws elongated; in some species the terminal joint is not dilated at the inner apical angle, so as to become palpiform; the head is large and transverse, and in *Sphæroma* the first segment of the thorax is laterally anteriorly produced so as to reach the anterior margin of the cephalon which it embraces on either side (see figure of *Sphæroma serratum*, Fabr. sp., Plate XV. Fig. 3). The mandibles robust and angulated at the extremity, the tips formed into sevaral distinct teeth, below which is a strong molar tubercle. Externally, also, the mandibles are furnished with a palpiform three-jointed appendage. The segments of the thorax do not exhibit, when viewed dorsally, the epimera-like structure of the basal joints of the legs observable in the *Idoteidæ*. The basal segments of the tail (abdomen) are more or less rudimentary, and are in general soldered together, more or less completely, so as to form, apparently, only a single joint, which in many species is furnished with large tubercles or spines.

CYCLOSPHÆROMA, H. Woodw., gen. nov.

General outline nearly circular, almost as broad as it is long. Cephalon rounded and tumid in outline; eyes moderately large, cornea vitreous; thoracic segments seven in number, broader than head-shield or telson, first segment coalesced with the cephalon; segments of abdomen coalesced together, but telson apparently distinct. Appendages ? (imperfectly preserved).

CYCLOSPHÆROMA TRILOBATUM, H. Woodw., gen. et sp. nov. (Pl. XV. Figs. 1*a*, *b*, and *c*.)

Description.—Outline of cephalon elliptical, twice as broad as long; glabella tumid, divided by strongly-marked furrows into three well-defined regions, a central, and two lateral parts; the central portion of the glabella is broadest in front, much constricted near the centre, expanding again into a small pentagonal area behind, where it unites with the first thoracic somite.

The two lateral lobes are ovate-oblong in form, broader in front, and narrower behind, where they abut against the constricted centre of the median lobe. The eyes, which are reniform in outline, and measure 5 mm. in length by 2½ mm. in breadth, occupy the outer posterior angles of the two lateral lobes; the cornea is smooth and glassy, but exhibits distinct facets within (when viewed under a good platyscopic lens). A narrow ridge separated by a double furrow marks the line of division between the cephalon and the first thoracic segment, which in the living *Sphæroma* usually encloses the posterior and lateral margins of the cephalon, with which it is more or less completely united.[1]

[1] In the majority of the Isopoda the "head" segments become fused with the first segment of the thorax, and form a cephalic shield which is freely movable upon the second thoracic segment. In *Serolis* the first and second thoracic segments are closely united, and completely fused dorsally, though the sterna of the two remain distinct; in some species an incomplete transverse suture upon the first epimera seems to mark the line of division between the two segments dorsally; in others the

Viewed from the front (see Pl. XV. Fig. 1*c*) the strongly-marked trilobation of the cephalon is still more clearly seen. The epistomial plate is observable attached to the frontal margin of the glabella; resembling somewhat a short heraldic "label," with two pendant square ends. Traces of the antennules and antennæ occupy the lateral frontal margin of the cephalon, which is deeply excavated on each side for the articulation of their broad basal joints.

The eyes stand out from the antero-lateral angles of the cephalon, the superciliary border being formed by the projecting margin of the lateral lobes, of the head and the inferior border by the encircling lateral margin of the first thoracic segment, which here unites with the front margin of the head-shield (cephalon).

Thoracic segments.—There are seven thoracic segments between the cephalon and the abdomen; each segment is very strongly corrugated, and is narrower in the centre along the median dorsal line, but more expanded towards its free margins or epimera. The first thoracic segment is, without doubt, united to the cephalon, and curves around the lateral margins of the head-shield; the second thoracic segment is also curved somewhat forward at its epimeral margins; the third and fourth are nearly straight; the fifth, sixth, and seventh segments curve rather backwards, being nearly twice as wide at the epimera as on the median dorsal line. The epimeral border of each segment is distinctly marked off and defined by a clear lateral line of division crossing all the segments from near the outer angle of the eye on each side to the anterior outer angle of the abdomen (see Pl. XV. Figs. 1*a*, 1*b*). The posterior margin of the cephalon and that of each thoracic segment, has a narrow raised border, separated by a furrow from the rest of the segment, forming the line of articulation between each segment and the one immediately succeeding it; this union is further strengthened by the enarthroidal articulation of each segment with its neighbouring one near its epimeral border.

Owing to the decorticated condition of the posterior portion of the fossil, any indication of the former divisions of the coalesced segments in the abdomen which may have existed in the crust are wanting; but we have evidence on the cast of two, or more, strong protuberances on this region of the body. The abdomen is two and a half times as broad as it is long, being extremely narrow laterally, somewhat rhomboidal in outline, and must have had spines along its posterior border. Behind the abdomen the body terminates in a "telson," or caudal shield, nearly three times as broad as it is long, but some of the margin of this shield has probably been lost. It had two powerful sub-median spines near the anterior border, and one in the centre near the posterior extremity, which is acutely pointed. The sides are strongly curved and hollowed out for the reception of the flat curved inner lobe of the lateral appendages

epimera of the two thoracic segments are completely united, and show no traces of their original distinctness; these epimera are always largely developed, and completely inclose the cephalic shield on both sides (Frank E. Beddard, Report on the Isopoda collected by H.M.S. "Challenger," during the years 1873–76. Part I. *Serolis*: Zoology, vol. xi. 1884, p. 8).

(uropodites), beneath which the outer lobe is generally concealed. Traces of these, and of the walking appendages of the thorax, can, unfortunately, only be made out in sections in the matrix. The surface of the head-shield and segments, as far as it has been preserved, is curiously carunculated, and the thoracic segments are also ornamented with lines of small tubercles varying in size; save the large spines and prominences which ornament the abdomen and telson, we are unable to speak on account of these portions having been decorticated; but we may fairly conclude that the surface was carunculated like the head-shield. There is a tendency towards a median line of small tubercles down the dorsum, commencing with a rather prominent one in the centre on the posterior border of the cephalon.

Dimensions.—Greatest breadth of cephalon, 25 millimètres; length 13 mm.; greatest breadth of thorax 33 mm.; length of seven thoracic segments on median line 13 mm.; length of abdomen and telson united 15 mm. Total length of fossil 41 mm.

Formation.—Great Oolite. *Locality.*—Northampton.

In the cabinet of Thomas Jesson, Esq., B.A., F.G.S.

Observations.—This is certainly one of the most curious examples of fossil Isopods I have yet seen. Its remarkably-shaped cephalon recalls to mind the genus *Lichas* amongst the Trilobites, but the general form is that of a true Isopod; nevertheless there are several points of great interest in the fossil before us. Besides the trilobation of the head-shield, one cannot fail to notice the prominent marginal eyes inclosed by the first thoracic somite, as is the case in the living genus *Sphæroma*. This segment, in *Sphæroma*; and the first and second thoracic segments united to the head in *Serolis* (see foot-note p. 530), are no doubt homologous with the genal portion (or "free-cheek" of Salter) in the head-shield of the Trilobites, thus affording another link by which to connect the modern Isopoda with the ancient and extinct Trilobita.[1]

I know of only one living form among the *Sphæromidæ* having such strong ornamentation upon the segments, head-shield and telson as is seen in *Cyclosphæroma*; I allude to the curious little form obtained by Dr. Milligan, at Flinder's Island, Bass's Straits, and named by the late Adam White *Ceratocephalus Grayanus*, MS.[2] (see Pl. XV. Figs. 2*a*, *b*, *c*). It has three horn-like prominences on its head-shield, and the telson has the same prolonged pointed termination as in our fossil, with similar protuberances and rugosities on its abdominal shield.

From *Archæoniscus* (Pl. XV. Fig. 4) the only other British Isopod from the Oolitic Series, *Cyclosphæroma* entirely differs, that Purbeck genus being now referred to the *Ægidæ*[3] on account of its free abdominal segments.

[1] See remarks in Monograph on the British Carboniferous Trilobites, by H. Woodward, Pal. Soc. Mon. 1883-84. p. 76.

[2] See Article "Crustacea," Encyclopædia Britannica, 1877, ninth edition, vol. vi. p. 659, fig. 72, A–E, by H. Woodward.

[3] See my paper "On Eocene Crustacea from Gurnet Bay, Isle of Wight," Quart. Journ. Geol. Soc. 1879, vol. xxxv. pl. xv. pp. 342-350, on *Archæoniscus*, p. 349.

Taking a review of the fossil Isopoda, we may venture to arrange them provisionally as follows:—

I. Bopyridæ.	*Bopyrus*, sp. (parasitic under carapace of *Palæocorystes*), Upper Greensand, Cambridge.
II. Ægidæ.	*Palæga*, 4 species, 2 Cretaceous, 2 Tertiary.
	Ægites, 1 species, Oolite, Solenhofen.
	Archæoniscus, 2 species, Purbeck, Swanage, etc.
III. Arcturidæ.	*Præarcturus*, 1 species, Old Red, Hereford.
	Arthropleura, 1 species, Coal Measures.
IV. Sphæromidæ.	*Sphæroma*, 4 species, Tertiary, Italy, Calabria, etc.
	Eosphæroma, 2 species, Eocene, Isle of Wight.
	Eosphæroma (=*Palæoniscus*), 2 species, Eocene and Miocene.
	Archæosphæroma, 1 species, Miocene, Bohemia.
	Cyclosphæroma, 1 species, Great Oolite, Northampton.
	Cymodocea, 1 species, Tertiary.
V. Oniscidæ.	*Oniscus*, 1 species, Tertiary (in amber).
	Triconiscus, 1 species, Tertiary (in amber).
	Porcellio, 3 species, Tertiary (in amber).
	Armadillo, 1 species, Miocene, Oeningen.

EXPLANATION OF PLATE XV.

Figs. 1–*a*, *b*, *c*. *Cyclosphæroma trilobatum*, H. Woodw., sp. nov., Great Oolite, Northampton.

Fig. 1*a*. Specimen natural size (*d* position of flagellum of antenna).

Fig. 1*b*. The same as fig. *a*, enlarged 1½ times.

Fig. 1*c*. The same, front view of cephalon, *a* antennule; *á*, part of the antenna; *e* epistomial plate.

Figs. 2*a*, *b*, *c*. *Ceratocephalus Grayanus* (A. White, MS.) living; Bass's Straits (Mus. Brit. collection), about 4 times natural size.

Fig. 2*a*. dorsal aspect.

Fig. 2*b*. ventral aspect.

Fig. 2*c*. frontal aspect of head.

Fig. 3. *Sphæroma serratum*, Fabr. sp. (length of living specimen about half an inch). English and French coasts, found under stones.

Fig. 4. *Archæoniscus Brodiei*, Milne-Edwards, Purbeck, Swanage, Dorset (magnified 3 times), now referred to the *Ægidæ*.

II.—Note on the Effect of Pressure upon Serpentine in the Pennine Alps.

By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

In some parts of the Alps serpentine is by no means a rare rock; indeed it is commoner than some geologists (myself included) once supposed, because much that was formerly comprehended under the term 'serpentinous schist' now proves to be true serpentine modified by the effects of pressure.

An Alpine serpentine, when in its most normal condition, so far as I have seen—and my experience is a fairly wide one—varies usually in colour from a dark green to almost black, a red tint being rare. Sometimes it is veined with a lighter green, and the rock that has been affected by pressure is usually of a paler colour, ranging from a fairly rich sage-green to a light greyish-green, the change being no doubt, in part at least, the result of weathering. Small grains of magnetite or chromite may often be detected. Except for this, the structure—apart from the results of mechanical action—is usually compact, though varieties with glittering crystals of bronzite and allied minerals occur. In this case the rock presents a con-

siderable resemblance to the dark serpentine from north of Cadgwith (Lizard), or to those found near Genoa or at Levanto.[1]

One of the largest masses of serpentine in the Alps occurs near the watershed of the Pennine Chain in the neighbourhood of Zermatt. In this region mountain-making has taken place on a grand scale, so that good opportunities are afforded of studying the effects of pressure as an agent of metamorphism. But before considering this, a few words of explanation are necessary for the sake of those who are not familiar with the geology of this region. The snowfields in the neighbourhood of Monte Rosa, upon the north-western side of the watershed, descend towards the Visp in two glaciers—the Gorner and the Findelen—which are separated by a huge buttress or spur. This culminates in a rocky ridge which runs parallel (roughly from east to west) with the former glacier. At its western end is a singular craggy tower, named the Riffelhorn (9616 feet); east of this, the ridge after a depression mounts to the well-known Gorner Grat (10,290 feet), from which it undulates upward along the Hochthäligrat (10,791 feet), and finally culminates in the Stockhorn (11,595 feet).

This huge spur to a great extent consists of serpentine; but on its northern shoulder a considerable area (above the Riffelhaus Inn, 8430 feet) is occupied by a tolerably hard fine-grained green schist, apparently bedded, in which a rather acicular hornblende and sometimes epidote are fairly conspicuous.[2] This mass is completely surrounded by serpentine. The latter rock continues to the summit of the Gorner Grat, where it is succeeded by calc-mica schists, associated with some fissile mica-schists and micaceous gneiss and with a hard white quartz-schist. This group—on the details of which it is, for the present purpose, needless to dwell—is followed, apparently in descending order, by a moderately coarse, rather micaceous, gneiss, of which, so far as I have seen, the remainder of the ridge, up to the peak of the Stockhorn, consists. The annexed section (Fig. 1), which is merely diagrammatic, may serve to render the relation of the rocks, described above, rather more clear.[3]

The serpentine no doubt forms part of the bed of the Gorner glacier, for of it, on the left bank, not only the rocks of the Lychen-

[1] See Geol. Mag. Dec. II. Vol. VI. p. 362; Vol. VII. p. 538. Descriptions of some Alpine serpentines will be found in Mr. Teall's British Petrography, p. 109, *et seq.*

[2] A specimen of one of the harder varieties which I have had sliced consists of a not very characteristic glaucophane (the greater part of the grains being, as has often been described, altered into a dull green hornblende), epidote, garnets (rather small), a little white mica, hematite, etc. It is difficult to offer an opinion as to the origin of these green schists. Some may be modified igneous rocks; others possibly altered tuffs.

[3] According to the Swiss Geological Survey there should be some rauchwacké interstratified near the base of the quartzite, but I omit this rock as I do not hold it to be a member of the crystalline series. The quartz-schist, green-schists, and calc-mica schists belong to the great group of crystalline schists which in the Alps have such a wide distribution and occur at the top of the Crystalline (probably Archæan) series.

bretter, on which rests the Ober Théodule glacier, but also the peak of the Klein Matterhorn (12,752 feet) consist. It appears again on the south side of the Twins and the Breithorn, in the Val d'Ayas, and patches of the same rock, sometimes of considerable size, occur at intervals about the Val d'Aoste and the Graian Alps. West of the above-named mass of serpentine comes a green schist which is indicated on the Swiss map by a colour different from that assigned to the Riffelberg schist; but to my eye there is no marked distinction between the two rocks. Serpentine also occurs in isolated patches among the schists for a distance of many miles in this direction, while on the north-east a kind of tongue protrudes from the mass forming the Riffelberg towards the base of the Findelen glacier, runs in a broad dyke-like mass on its right bank, and then forms another great patch which culminates in the summits of the Allaleinhorn, Rimpfschhorn, and Strahlhorn, whence it extends even as far as the Fee-alp above the Saasthal. The distribution of the serpentine, as mentioned above, is inexplicable on any other supposition than that it is an intrusive rock of igneous origin, though I have not yet seen it either sending off dykes or cutting distinctly across the bedding of the schists. This negative evidence, however, is of little weight, for in the Alps junctions are very often commonly covered up by débris, and I deemed it unnecessary to spend much time in hunting for them, because evidence already obtained in other localities has fully satisfied me as to the history of an ordinary serpentine.

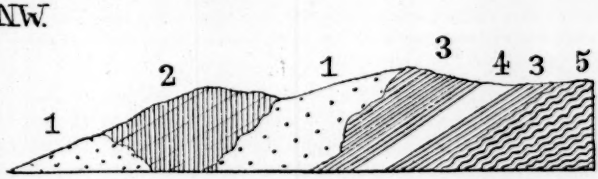

Fig. 1.—Section through Gorner Grat.

(1) Serpentine. (2) Green schist. (3) Calc-mica schist. (4) Quartz-schist. (5) Micaceous gneiss.

The main mass of serpentine, described above, together with the enclosed hornblendic schist, measures rather more than $3\frac{1}{2}$ miles from E. to W. and rather less than $2\frac{1}{4}$ miles from N. to S.; but if we measure from the summit of the Klein Matterhorn to the furthest part of the margin, in a direction rather east of north, the distance is more than five miles. Thus the mass of serpentine at the head of the Vispthal is not less important than that of the Lizard in Cornwall.

Some at least of the schists through which the serpentine appears to have broken must be rocks of sedimentary origin. Whatever may be that of the green-schists and certain of the mica-schists and gneisses in this series, it is impossible to doubt that of the quartz-schist and the calc-mica schist. In the latter micaceous and calcareous bands, these sometimes becoming a crystalline marble, so constantly alternate, that they seem only explicable on the hypothesis of an

interstratification of more argillaceous and more calcareous layers. It is also evident that these rocks, after they had assumed a crystalline condition, were modified by a strong pressure, definite in direction. This pressure in many cases appears to have acted at right angles to the planes of the original, or 'stratification-foliation,' and to have superinduced upon it a secondary or 'cleavage-foliation' in the same direction; but sometimes, as for instance may be seen at the very summit of the Gorner Grat, the former structure is folded so as to cross the direction of the latter, which then usually becomes inconspicuous. The bedding in these schists dips roughly to the N.W. or a little W. of this, at an average angle of about 40°, but minor disturbances make a very precise determination almost impossible.

Pyroxenic constituents are generally absent from the serpentine of the Gorner Grat, so far as I have seen, but grains of iron-oxide (magnetite or perhaps chromite) which sometimes attain a fair size are rather common. Thus the rock originally must have been the

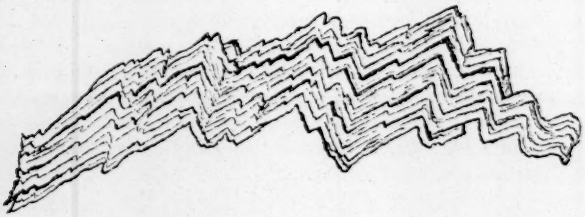

Fig. 2.—Contortions in Slaty Serpentine (natural size).

variety of peridotite called dunite. Occasionally we find specimens of fairly normal serpentine, but the rock commonly is more or less fissile, looking compressed or even crushed. In some places it is converted into a veritable slate, and the mountain is strewn with slabs, which have smooth level surfaces, and exhibit a structure as compact as that of an argillite, so that their true nature might readily be overlooked. But the more normal and only slightly cleaved serpentine can be traced into this slaty kind, which we then see indicates only localities of greater pressure or of less strength in the rock-mass. In some instances (as near the base of the Riffelhorn on its northern side) the serpentine is so fissile that it can be split into films hardly thicker than an ordinary visiting card. I brought away a specimen, perhaps about half a dozen square inches in area (larger could have been easily obtained), which is nowhere thicker than an eighth of an inch, and in not a few parts is actually translucent. Not far from this place I noticed specimens which seemed to indicate that the rock had been twice affected by pressure, for the thin slaty layers were bent into a series of V-like folds, like a row of gables, perhaps half an inch high, and rather less than an inch wide, these bent layers being separable one from another (Fig. 2).[1]

[1] A very fine specimen, on a scale about five times that figured above, was found last summer at the top of the Théodule Pass by Prof. W. Ramsay, F.R.S., and given to our Museum at University College.

I have examined microscopically slices cut from a slab (about 6 or 7 tenths of an inch in thickness) of the above described slaty serpentine, collected from the western slopes of the Gorner Grat. Both were cut at right angles to the flat surface, one along what appeared to be the 'dip' of the cleavage and the other with its 'strike.' The structure in the two slices differs little, but the former is slightly more streaky. The rock[1] consists almost entirely of two minerals. One, forming the matrix, occurs in small translucent flakes or streaky folia of a very pale olive colour; the other, an iron oxide, in rather small black grains (Fig. 3). The former, with crossing Nicols, resembles a streaky felted mass, the folia varying from a rather regular to a lobate or irregular outline. Commonly the flakes lie with their longer axes parallel with the cleavage-planes. Occa-

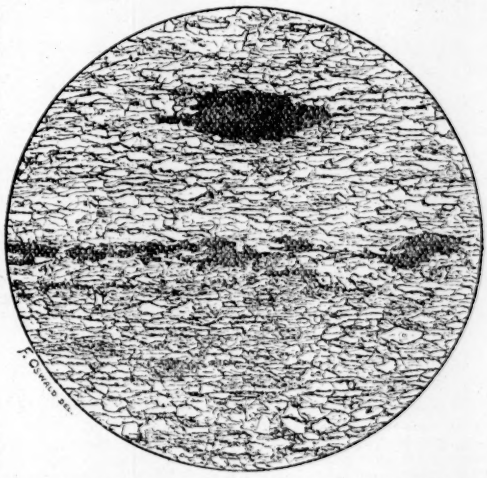

Fig. 3.—Section of Slaty Serpentine from near the summit of Gorner Grat. × 50.

sionally the mineral exhibits a cleavage like a mica, parallel to which extinction occurs, and these also lie in the above direction. Hence the slide as a whole is darkest when placed with the boundary of the cleavage surface parallel with the vibration plane of either Nicol.[2] Then a darkish field is speckled by irregular granules of low tints, white, greyish, or yellowish. It is brightest when the same lines are equally inclined to the vibration planes, a yellowish tint (yellow to orange) dominating. In this position the streaky interweaving of the mineral flakes is more conspicuous. This structure bears some resemblance to tapestry work in wool, where the stitches are irregular in length and more or less in one general direction. Difficult, however, as it is to describe the appearance, it is

[1] The hardness of the rock is between 3 and 3·5, and its S.G. = 2·67.

[2] Possibly the mineral may be (in part at least) antigorite. Cf. the description in Teall's British Petrography, p. 113. The larger flakes in my slides show a faint dichroism, but it is imperceptible in the smaller.

familiar to all students of rocks modified by pressure as one which occurs when a mass, composed of grains of fairly uniform size and strength, has been much compressed. The component grains seem to have been flattened out and squeezed together. The other constituent, the iron oxide, can be readily seen by the unaided eye, forming black lines, up to about $\frac{3}{4}$ inch in length, parallel with the rock cleavage, like strokes made with a thick pen. These, on microscopic examination, are found to be composed of grains or granules, more or less aggregated in regular lines, and usually not exhibiting a crystalline form, but being, so far as can be determined, rather lenticular in outline. Generally they are black and perfectly opaque. Sometimes, however, they appear slightly translucent and of a brownish tint, and the adjoining matrix is stained with the same colour, which penetrates for some little distance in a dendritic fashion. There can, I think, be no doubt that these represent grains of magnetite or possibly chromite, which have been crushed up and arranged by pressure in their present form. Once or twice I note lenticular clusters of larger and more definite flakes of the doubly refracting mineral, but can find no distinct trace of a pyroxenic constituent.

At one spot we find in the low bosses which crop out from among the scattered débris two rocks in association, both of which seem to differ from the serpentine. The one is a dark dull-green chloritic rock; the other a talcose rock of a rather pale greyish colour. The hardness of the former is about 2; the latter is still softer, being easily scratched with the finger-nail. The 'chloritic' rock occurs in a series of irregular reef-like masses, and I have no doubt that it is intrusive in the talcose, though both evidently have been modified by pressure and greatly altered from their original condition.[1] The former, when examined under the microscope, is found to consist of a flaky mineral, apparently belonging to the chlorite group, with some flakes and irregular grains of an opaque iron-oxide, and (in the junction-specimens) an occasional grain of a clear rather granular mineral. The chloritic mineral has one well-defined cleavage like a mica; it is moderately dichroic, showing a light dull-green, with vibrations parallel with the cleavage-planes, and a very pale straw colour with vibrations perpendicular to them. The dichroism is more marked in a junction-specimen (where the flakes have a more distinctly parallel arrangement), but this may only be due to a difference in the thickness of the slides. The polarization tints are low, but rather brighter in the latter specimen. Extinction seems generally to take place parallel with the cleavage-planes, but occasionally there is room for doubt on this point, and it appears to be most complete at a very small angle with them. In the junction-specimens the grains of iron-oxide are smaller, and more distinctly linear in arrangement than in the other. In form they resemble hematite. The third mineral has a rather granular structure, is colourless, and gives low polarization tints. I have not seldom seen

[1] I am greatly indebted to Mr. J. Eccles, F.G.S., for verifying the opinion which I had formed, and for much additional information.

a similar mineral in rocks of this character; it has a general resemblance to zoisite, but I cannot venture to identify it.

I am indebted to the kindness of Mr. J. C. Chorley for a bulk analysis of this rock (made in Professor Ramsay's laboratory at University College). It is as follows (No. I.):

	No. I.			No. II.[1]
SiO_2	= 28·92	...	...	28·56
Al_2O_3	= 44·31	...	...	39·54
Fe_2O_3	= 10·86	...	...	0·99
FeO	= 2·93	...	...	2·87
MgO	= 3·98	...	...	15·79
CaO	= trace	...	...	1·73
Na_2O	= 2·98	...	...	0·70
K_2O	= 0·67			
Moisture	= 5·70	...	...	11·09
	100·35			101·27

Specific gravity of the rock 2·81. This result appeared to be of so much interest that Mr. Chorley kindly verified it by a partial analysis of another sample, and obtained SiO_2=29·88, Al_2O_3=43·56, Fe_2O_3=10·65. Thus there can be no doubt that the rock, and consequently its chief constituent, has an unusually low percentage of silica and an unusually high one of alumina. It bears macroscopically and microscopically a very close resemblance to a rock described by myself from near Rhoscolyn, Anglesey, and an analysis of that rock made by Mr. F. T. S. Houghton is quoted for comparison (No. II.)[2] The analyses present considerable resemblances: the ratio of the SiO_2 to the Al_2O_3 is but slightly different, there is a larger amount of water in the Anglesey rock, and a smaller amount of the iron oxides. This, however, may be explained. The first is strictly a bulk analysis, not so the second. This rock contains rather conspicuous octahedral crystals of magnetite (probably containing some Cr_2O_3). These were removed because the analysis was made to ascertain of what mineral the matrix was composed, and what was its history. The most marked discrepancy between the two analyses is the amount of MgO, which indicates the presence, in the Rhoscolyn rock, of a mineral richer in magnesia. For purposes of comparison let us denote the alumina in each rock by 100. Then we have approximately.[3]

No. I. (Gorner Grat).				No. II. (Rhoscolyn).
SiO_2 = 65	...	...	...	72
FeO = 6·5	...	...	...	7
MgO = 9	...	...	...	39

Hence it seems to follow that the latter rock must either consist of a somewhat different mineral or contain a second mineral rich in magnesia. Still both analyses seem to indicate the presence of a mineral with a low silica percentage, a moderate one of magnesia and iron-protoxide, and a very high one of alumina.

[1] Also traces of Cr_2O_3 and MnO.

[2] Q.J.G.S. vol. xxxvii. (1881) pp. 43-45.

[3] The Fe_2O_3 is not indicated in the comparison, because I believe most of it is present in No. I. as hematite. Thus it will not help us for the present purpose.

What then is this mineral, and what was the rock originally?

I have examined a considerable number of analyses of minerals which have a general resemblance to that dominant in the above described rocks, and are quoted in Dana's "Mineralogy," Heddle's "Chloritic Minerals,"[1] and other works.[2] Now in the case of the Gorner Grat rock the microscope shows us that it is mainly composed of one mineral. Hence the composition of this must be roughly represented by the bulk analysis of the rock (omitting most of the Fe_2O_3). Therefore the mineral cannot be pennite, ripidolite, or chlorite (clinochlore), *i.e.* not one of the chlorites as defined by Professor Heddle. But this analysis nearly approaches those of chloritoid, given by him (I. and II.) except in the presence of alkalies and the much lower percentage of FeO.

	I.	II.	III.[3]	IV.[4]
SiO_2	24·47	25·36	24·90	24·40
Al_2O_3	41·34	41·74	40·99	42·80
Fe_2O_3	·38	3·89	·55	19·17
FeO	18·52	13·93	24·28	
MnO	·91	·92	—	—
CaO	·30	·90	—	—
MgO	6·80	6·82	3·33	6·17
K_2O	—	—	—	—
Na_2O	—	—	—	—
H_2O	6·98	6·57	7·82	6·90
	99·70	100·41	101·87	99·44

But the hardness of chloritoid is 5·5 to 6, while in this case it is about 2; it has also a higher specific gravity, viz. about 3·5. However, there can be little doubt that it is very nearly related to chloritoid and a member of Tschermak's 'Clintonite' group,[5] which contains this mineral with Ottrelite, Xanthophyllite, etc.

I have not been more successful in endeavouring to ascertain the original nature of the rock. A peridotite is obviously out of the question; the excess of the alumina over the silica is much greater than in any analysis given by Roth. If, however, we suppose that silica has been removed (perhaps with some magnesia and lime), we are perplexed at the percentage of alkalies, which is about that of a normal basalt.

The adjacent schist adds to our difficulty.[6] Its softness and microscopic structure justify us in regarding it as a talc-schist, and the field evidence is in favour of its being only an altered condition of the slaty serpentine. This was my own opinion at the time, and Mr. Eccles, who kindly undertook to re-examine the question, informs me that though the change from the one rock to the other is abrupt, this conclusion appears the more probable.[7] To convert

[1] Trans. Royal Soc. Edin. vol. xxix. (1879) p. 55.

[2] I am indebted to Miss C. A. Raisin for much help in this search.

[3] Analysis of Chloritoid, Tschermak and Sipöcz, Sitz. k.k. Akad. Wiss. 1879.

[4] Analysis of 'Sismondine' from Zermatt, Des Cloiseaux, Bull. Soc. Min. vol. vii. p. 80.

[5] *Loc. cit.*

[6] Curiously enough there is a similar association in Anglesey, Q.J.G.S. vol. xxxvii. p. 44.

[7] After microscopic examination of a specimen collected by Mr. Eccles, I think

a schisty serpentine into a talc-schist, either much SiO_2 must be added or much MgO removed. The condition and structure of the rock is not favourable to the former explanation; it seems more probable that the alteration has been by a 'leaching out' of the magnesia. It is therefore difficult to understand the reason of such different changes in two adjacent rocks, unless it be that an aluminous silicate more readily parts with its silica, and a magnesian silicate with its magnesia, in favour of which there is some evidence. At present, however, I think it safer to restrict myself to calling attention to the facts.

Other specimens of slaty serpentine in my collection exhibit a structure like that described above. For instance in one from the western side of the Col di Vallante (Cottian Alps), which is extremely fissile and of a distinctly green colour, the microscopic structure is yet more minute, the rock more fissile (for it splits up in grinding), but the slice gives higher polarization tints. This also exhibits an occasional bending or 'rucking' of the 'foliation,' which sometimes has produced a 'strain-slip' cleavage. Another specimen, from near Verrex (at the opening of the Val d'Ayas), exhibits a like structure, but in it, I think, a little enstatite has been present. In one less conspicuously fissile, from the junction of glens at the head of the Val Malenco, enstatite and augite are certainly present. Sometimes the latter mineral is crushed to a powder, which has a rather dusty aspect, while the larger granules exhibit the bright tints customary in augite. Here and there a characteristic fragment of that mineral can be found, and we may note that, though the pressure has been very great, it remains augite, and has not been altered into hornblende.[1] This variety of serpentine must exist in some part of the *massif* in the region of the Gorner glacier, for I collected several years since a specimen on one of its moraines, of which, as I had some doubt as to the true nature of the rock, I examined a slide. Here the matrix is less completely crushed than in the specimens described above, and there is a large amount of this granular pulverized augite (at least I identify it with this mineral after comparison with the better preserved examples in the last-named slide). Specimens from other parts of the Alps exhibit both varieties of serpentine, and the effects of less severe pressure; but on these it is needless to enlarge.

It has been suggested that the streaky structure which is rather conspicuous in some of the Lizard serpentines (*e.g.* a variety on Goonhilly Downs and a common type at Porthalla[2]) may be due to pressure.[3] Applying the knowledge obtained in the present investigation, I may venture to express the opinion that these Cornish rocks have not been materially affected by pressure since they

there can be little doubt the rock is an altered serpentine. The dominant mineral has all the characters of talc, but there are several grains of calcite which, by their mode of occurrence, suggest replacement (? of augite).

[1] There are however not a few minute grains of a honey-brown, somewhat dichroic, mineral which *may* be a variety of hornblende.

[2] Q.J.G.S. vol. xxxix. pp. 21–23.

[3] Geol. Mag. Dec. III. Vol. IV. p. 137.

became serpentines. It might, however, still be affirmed that they were crushed as peridotites and were afterwards converted into serpentines. I possess only one specimen of a peridotite modified by pressure, but this lends no support to that hypothesis, and the structure of the accidental constituents in the Cornish serpentines does not appear to suggest it, so that I think we must seek for some other explanation.

It results then from this investigation that in a large number of cases the direct effect of 'dynamometamorphism' on a serpentine is not to produce any marked mineral change, but only to reduce the magnitude of the constituents and to impress upon them a linear arrangement, more or less marked. Under ordinary circumstances it does not appear to generate one of the soft unctuous talcose schists, though such a change sometimes occurs. This, however, must be accompanied, as stated above, by considerable chemical alteration, because in olivine or serpentine (and in the rocks mainly composed of these minerals) the silica and the magnesia are nearly equal in amount; while in talc the former is about double that of the latter. There is also a lower proportion of H_2O. Perhaps, in such cases, some local cause may have given to the water a more distinctly solvent action.

III.—A Revision of the Group of *Nautilus elegans*, J. Sowerby.

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OWING to the defective character of Sowerby's description and figure of *Nautilus elegans*, the latter has been variously interpreted, specimens belonging to other species having been frequently referred to it. In the present paper we shall show what is the true *N. elegans*, tracing the history of the type-specimen, which we have been fortunate enough to identify in the collection of the British Museum. This done, we shall proceed to describe three other species, viz. *N. elegantoides*, d'Orbigny, *N. Atlas*, Whiteaves, and *N. pseudoelegans*, d'Orbigny, all evidently allied to *N. elegans*, and forming with it a group of species which may be appropriately called the "Group of *Nautilus elegans*."

The identity of *Nautilus elegans*, J. Sowerby, has hitherto been completely mistaken, owing to the uncertainty existing as to the true character of Sowerby's fossil, the type of which had not been recognized.

The following is Sowerby's description of this species: "Gibbose, umbilicate, with numerous linear, reflexed radiating sulci. About two-thirds as thick as wide; the septa are rather numerous, gently waved; the aperture is obtusely sagittate, with the posterior angles truncated; umbilicus small, perhaps closed." Respecting the type-specimen Sowerby states, "This fine specimen was found in the chalk marle, at Ringmer in Sussex, in 1814, by Mr. Mantell."

It is undoubtedly Sowerby's type-specimen which Mantell figures in his Fossils of the South Downs, tab. xx. fig. 1, and which he

states "was discovered in a marl bank at Middleham, in the winter of 1814."

The apparent discrepancy between these two localities is explained by Mantell's remark on page 100 of the work just quoted, viz. that "a low bank at Middleham in the parish of Ringmer, near the seat of the Rev. J. Constable, contains *Hamites*, *Turrilites*, *Nautilites*, *Ammonites* and *Inocerami*."

There is in the British Museum (Natural History) a specimen from Dr. Mantell's collection, bearing an old label in faded ink, to the following effect:—"*Nautilus elegans*, Min. Con. pl. 116, ... Chalk Marl . . . . . Estate of Rev. J. Constable, Ringmer."

On comparing this fossil with the figures of *Nautilus elegans* given by Sowerby[1] and Mantell,[2] no doubt can be entertained as to its identity with them. The figures have been restored to some extent, but not in such a way as to disguise altogether the characters of the fossil. The foreshortening of the figure, a practice often indulged in by Sowerby, added not a little to the difficulty of realizing the form of the shell.[3] Moreover, Sowerby's figure is reversed.

An exact drawing of the fossil is here given (Fig. 1, p. 548), which is intended to supply the deficiencies of Sowerby's figure, and render the species more easily recognizable.

Having identified Sowerby's type-specimen, it will now be useful to notice, on the one hand, those species which, being in reality *N. elegans*, have had some other name erroneously applied to them, and, on the other hand, those species which have been wrongly named *N. elegans*. Sharpe has fallen into both these errors. His *Nautilus elegans*[4] is not that of Sowerby, but a much wider and thicker shell, with closed umbilicus and the siphuncle above the centre. The specimen which he figured as *Nautilus pseudoelegans*[5] is now in the Museum of the Geological Society of London, and an examination of the fossil leaves no doubt whatever that it is identical with Sowerby's type of *N. elegans*, as Sharpe's figure, which is fairly accurate, had indeed led one to conclude.

The source of this confusion is easily explained. Sharpe has relied upon d'Orbigny's descriptions of the Chalk Nautili, in which the definition of *N. elegans* (Pal. Franç. Terr. Crét. 1840, t. 1, p. 87) departs so widely from Sowerby's, as to show that d'Orbigny's fossil[6] was distinct from the latter.

Dr. Paul Fischer, of the Museum of Natural History, Paris, with very great kindness, sent to one of us the original specimen figured by

[1] Min. Conch. vol. ii. 1816, p. 33, pl. cxvi.

[2] Fossils of the South Downs; or Illustrations of the Geology of Sussex, p. 112, pl. xx. f. 1 (not pl. xxi. ff. 1, 4, 8).

[3] This has been a stumbling-block to many. F. B. Meek (United States Geol. Surv. Terr. vol. ix. 1876, p. 500, footnote) says:—"his [Sowerby's] single figure being an oblique view does not show the form of the aperture."

[4] "Description of the Fossil Remains of Mollusca found in the Chalk of England" (Mon. Pal. Soc.), 1853, pt. i. Cephalopoda, p. 12, pl. iii. f. 3; pl. iv. f. 1.

[5] *Ibid.* p. 13, pl. iv. figs. 2*a*, 2*b*.

[6] D'Orbigny's *N. elegans* will now be known as *Nautilus Atlas*, a name proposed for it by J. F. Whiteaves (*see* post, p. 550).

d'Orbigny under the name *Nautilus elegans* (Pal. Franç. Terr. Crét. 1840, tom. i. p. 87, pl. xix.), thus enabling us to observe the difference between the latter, as interpreted by d'Orbigny, and the true *Nautilus elegans* of Sowerby (see Fig. 1).

Along with the figured type of *Nautilus elegans*, d'Orbigny, kindly lent by Dr. Fischer, is one which, though sent as an example of that species, differs materially from d'Orbigny's shell, its form being much more compressed, and the sutures closer together and more curved than those of the latter. These characters unite it with the *N. elegans* of Sowerby, and it is interesting to find this species occurring in France. Dr. Fischer states that the French specimen is from the Cénomanien (Lower Chalk).

Pictet and Campiche,[1] writing in 1859, give no figures of *N. elegans*, but they recapitulate its characters (p. 117), saying, however, that its umbilicus is "très-grand," whereas Sowerby describes it as "small, perhaps closed." On the same page of their work these authors, referring to Mantell's figure of *N. elegans*, say that it probably represents a different species; but it is in truth a figure of the same specimen as that which formed the subject of Sowerby's figure in the "Mineral Conchology."

In 1866 Stoliczka,[2] referring to the Indian Cretaceous specimens, identified by Blanford as *Nautilus elegans*, states that they "agree well with the European [form], and the external position of the siphuncle can be often noticed on fragments in our collection." The "external position of the siphuncle" and the general form of the shell would associate the Indian species with d'Orbigny's, were it not that the ribbing in the latter appears to be finer, and the French form is, perhaps, on the whole, somewhat thicker than the Indian. As we have been able to examine only the single, badly-preserved young example of the latter which is in the British Museum, we cannot say whether d'Orbigny's fossil is or is not identical with Blanford's.

In 1876 Dr. Clemens Schlüter,[3] in describing a new species of *Nautilus*, which he designates *N. Sharpei*, remarks upon the distinctness of the *Nautilus elegans* of d'Orbigny and Sharpe from the *N. elegans* of Sowerby.

Meek, in association with Hayden,[4] described in 1862 an American fossil as *N. elegans*, var. *Nebrascensis*.

Not satisfied with Sowerby's imperfect description and foreshortened figure, Meek[5] adopted with some hesitation Sharpe's interpretation of *Nautilus elegans*, and in 1876, after reconsideration, he gave up the varietal name on account of the resemblance of his form to the *N. elegans* of Sharpe, which he naturally supposed to be identical with Sowerby's species. He evidently, however, had his

[1] Description des Foss. du Terr. Crét. Environs de Sainte-Croix (Pal. Suisse), sér. ii. pt. i. 1859, pp. 117, 136.

[2] Mem. Geol. Survey India—Palæont. Indica—I. Cretaceous Cephalopoda of Southern India, 1866, p. 209.

[3] Cephalopoden der oberen deutschen Kreide, Abth. ii., Palæontographica, 1876, Band xxiv. (5) 171, Taf. xlvi. ff. 5–7.

[4] Proceed. Acad. Nat. Sci. Philadelphia, 1862, vol. xiv. p. 25.

[5] United States Geol. Surv. Terr. 1876, vol. ix. pp. 499–501.

doubts about the correctness of Sharpe's identification of the species in question; for, after describing the American form, he remarks that he believes the latter "will be found to agree so closely with Sowerby's species, that there may be no necessity for separating it, even as a variety—that is, if Mr. Sharpe's illustrations can be relied upon." He continues, "From Sowerby's application of the words 'indistinctly sagittate,' however, to the aperture, it would seem that his type-specimen must be much more compressed than ours, which, as already stated, agrees well with Sharpe's figures in form. As Sharpe ought to have been well acquainted, however, with Sowerby's species, I infer that the latter's original type may have been *accidentally* compressed." It will be seen from this quotation that Meek was not quite satisfied in his mind as to the identity of Sharpe's species with Sowerby's. He comments upon the retention by Pictet,[1] and also by Blanford,[2] of the name *Nautilus elegans* for d'Orbigny's type; and remarks that "if *N. elegans*, d'Orbigny, is specifically distinct from the previously published *N. elegans*, Sowerby (which seems very probable), of course d'Orbigny's shell will have to receive some other name, as two species of the same genus cannot retain the same name." The required name has been supplied by Mr. Whiteaves,[3] who proposes to call d'Orbigny's fossil *Nautilus Atlas*.

Judging by Meek's careful description and admirable figures of the American form, it appears to be distinct from *N. elegans*, Sowerby, and also from d'Orbigny's and Sharpe's *N. elegans*, which have been renamed *N. Atlas*. Although Meek's form has undoubted affinities with the last-named species, it differs in having a much wider shell, an open though small umbilicus, at least in the adult, and the siphuncle somewhat nearer the centre. On the whole, it is more like the Indian form already mentioned than the French form, *N. Atlas*.

Regarding Meek's form—*N. elegans*, var. *Nebrascensis*—Mr. Whiteaves[4] expresses the following opinion:—that "the description of the Nebraska fossil . . . . accords much better with that of *N. Atlas* (nobis) than with Sowerby's diagnosis of his *N. elegans*. The globose shape, together with the position of the siphuncle in the American shell, are in favour of this view, but it is possible that the varietal name, proposed by Mr. Meek, may have to be raised to specific rank, as the sculpture of the so-called 'variety *Nebrascensis*' is said to consist of ribs which are 'five times as broad as the grooves between,' and in this respect it differs from *N. Atlas*, as well as from allied species."

It is due to Mr. Whiteaves to observe that he arrived at the conclusion, from a careful study of the descriptions of the species, that the *Nautilus elegans* of d'Orbigny and of Sharpe was distinct from

[1] Descr. des Foss. du Terr. Crét. des Environs de Sainte-Croix (Pal. Suisse), sér. ii. pt. i, 1859, p. 117.

[2] Mem. Geol. Surv. India—Palæont. Indica—I. Cretaceous Cephalopoda of Southern India, 1861, p. 29; Ibid. 1866, p. 209.

[3] Geological Survey of Canada—Mesozoic Fossils, 1876, vol. i. pt. i. p. 17.

[4] *Ibid.* p. 18.

the *N. elegans* of Sowerby, before he was aware that Pictet[1] had already pointed this out.

With Sowerby's *Nautilus elegans* has often been confounded the *Nautilus pseudoelegans* of d'Orbigny. The true characters of the latter species we have been able to observe from two specimens, which Dr. Paul Fischer, of the Museum of Natural History, Paris, very kindly sent to one of us from the d'Orbigny collection. One of these is figured in Fig. 3. The species is readily distinguished from *Nautilus elegans* by its much thicker and more robust form, closer septa, the position of its siphuncle, and the coarser character of its ornaments. It is also met with at a lower horizon, both in England and France, than Sowerby's species. From *N. Atlas* it differs in the broader periphery, open umbilicus, closer septa, and position of its siphuncle, which is near the inner margin of the septa, instead of the outer, as in *N. Atlas*. The ornamentation of the test is also much finer in the latter than it is in the present species. The *N. pseudoelegans* referred to by English geologists is probably that of Sharpe, which has been shown above to be Sowerby's *N. elegans*.

According to MM. Pictet and Campiche[2] *N. pseudoelegans* presents some variations in the Sainte-Croix specimens, those authors distinguishing four distinct types, of which they give figures (plates xiv. and xiv. *bis* of the work cited above). The first of these types, which is from Yonne, is remarkable for the smoothness of the test in the young shell; the second, from Sainte-Croix, differs very little from the first, being only slightly more compressed. The third type scarcely differs at all from the two preceding ones. In the fourth some slight variations in the position of the siphuncle are noticed. In the Indian examples of the present species figured by Blanford the ribs are much coarser than they are in the English specimens, and indeed on comparing the specimens from the d'Orbigny collection with Blanford and Stoliczka's[3] figures and descriptions there is reason to doubt the identity of the Indian with the European forms, although the two forms are nearly related. Blanford's description of the species is as follows:—"Shell inflated, evenly rounded, ornamented with numerous sulcations generally visible on the cast. Ventral area broad and rounded. Umbilicus impressed and very small in the cast; the perforation not exceeding $\frac{1}{20}$ of the diameter of the shell. The sulcations rather variable in width, narrow on most specimens, forming a very obtuse angulation on the median ventral line, whence the sulci curve forward towards the umbilicus (generally becoming obsolete on the sides of the cast), and forming a very slight flexure towards the umbilicus. Aperture orbicular; septa numerous, about 22 to the whorl, the margins [sutures] slightly flexuous at the sides, straight or slightly convex

[1] Descr. des Foss. du Terr. Crét. des Environs de Sainte-Croix (Pal. Suisse), sér. ii. pt. i. 1859, p. 117.

[2] *Ibid.* pp. 123–128.

[3] Mem. Geol. Surv. of India—Palæont. Indica— I. Cretaceous Cephalopoda of Southern India, p. 33, pl. xvii. f. 3, pl. xviii. ff. 3, 3*a*, 3*b*, pl. xix. pl. xx. ff. 1, 1*a*.

in the ventral region." The siphuncle was subsequently to this description ascertained to be "rather approaching to the inner margin of the septa."[1]

The principal feature in which the Indian differs from the European form lies in the more narrowly rounded periphery, and altogether less robust habit of the shell, next in the smaller umbilicus, and, lastly, in the character of the ribbing, which seems to have been coarser in the Indian than it is in the French form. Blanford's fig. 2 (*loc. cit.* pl. xix.) certainly gives one the impression of being that of a much narrower shell than d'Orbigny's type. As all the specimens in the Indian Survey Collection are stated to be casts, it is not surprising that their characters (especially the ornaments of the test) should not have been very satisfactorily made out.

The four species comprised in the group of *Nautilus elegans*, J. Sowerby, will now be described, beginning with the typical form. We have confined ourselves to those few references in which the species can be verified by means of adequate descriptions and figures.

Nautilus elegans, J. Sowerby.

1816. *Nautilus elegans*, J. Sowerby, Min. Conch. vol. ii. p. 33, pl. cxvi.
1822. *Nautilus elegans*, Mantell, The Fossils of the South Downs; or, Illustrations of the Geology of Sussex, p. 112, pl. xx. fig. 1 (not pl. xxi. figs. 1, 4, 8).
1849. *Nautilus elegans*, Quenstedt, Die Cephalopoden, p. 57, Tab. ii. fig. 7 (reduced from Sowerby's figure in the Min. Conch. pl. cxvi.).
1853. *Nautilus pseudoelegans*, Sharpe, Description of the Fossil Remains of Mollusca found in the Chalk of England (Mon. Pal. Soc.), pt. 1, Cephalopoda, p. 13, pl. iv. figs. 2*a*, 2*b* (not pl. iii. fig. 3, nor pl. iv. fig. 1).
? 1872. *Nautilus elegans*, Geinitz, Palæontographica, Band xx. pt. ii. "Das Elbthalgebirge in Sachsen," pt. ii. p. 181, Taf. xxxii. fig. 6.
[*Not* 1840. *Nautilus elegans*, d'Orbigny, Paléontologie Française, Terrains Crét. tome i. p. 87, pl. xix.—1850. *Nautilus elegans*, d'Orbigny, Prodr. de Paléont. Stratigr. tome ii. p. 145.—1853. *Nautilus elegans*, Sharpe, Description of the Fossil Remains of Mollusca found in the Chalk of England, pt. i. Ceph., Mon. Pal. Soc. p. 12, pl. iii. fig. 3; pl. iv. fig. 1.—1861. *Nautilus elegans*, Blanford, Mem. Geol. Surv. India—Palæontologia Indica—I. Cretaceous Cephalopoda of Southern India, p. 29, pl. viii. fig. 4; pl. xvi. figs. 1–4.—1866, *Nautilus elegans*, Stoliczka, Mem. Geol. Surv. India—Palæont. Indica, I. Cretaceous Cephalopoda of Southern India, p. 209.—1876. *Nautilus elegans*, Meek, Rep. United States Geol. Surv. Terr. vol. ix. p. 499, pl. viii. figs. 2*a–c*.]

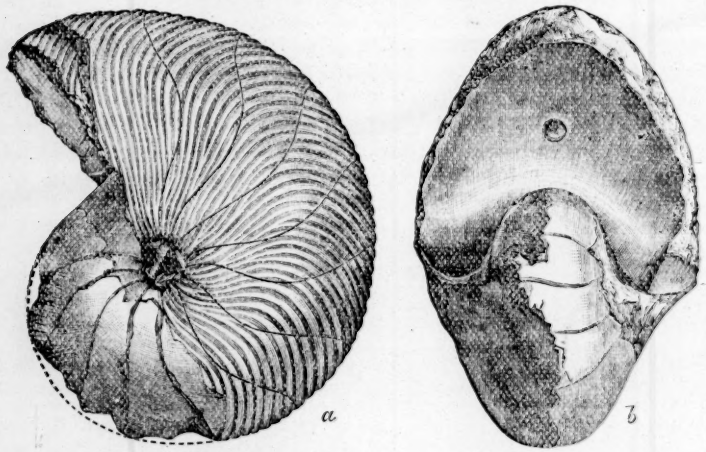
Specific Characters.—"Gibbose, umbilicate, with numerous linear, reflexed, radiating sulci. About two-thirds as thick as wide; the septa are rather numerous, gently waved; the aperture is obtusely sagittate, with the posterior angles truncated; umbilicus small, perhaps closed." (*J. Sowerby.*)

A more exact description of the species may be given as follows: "Shell inflated, somewhat flattened upon the sides, rather narrowly rounded upon the periphery; whorls deeply embracing. Umbilicus small. Septa moderately distant from each other, being $1\frac{1}{3}$ inches apart upon the periphery in the type-specimen, where the height of the whorl, measured from the umbilicus, is about $4\frac{1}{4}$ inches. The

[1] Stoliczka, Mem. Geol. Surv. of India—Palæont. Indica—I. Cretaceous Cephalapoda of Southern India, p. 210, pl. xciii. f. 3.

sutures are bent backwards in a broad sinus on the sides of the shell, and are nearly straight on the periphery. Siphuncle about its own diameter below the centre. Ornaments of the test (type-specimen) consisting of regular, transverse, prominent ribs (flattened in casts), separated by interspaces about half the width of the ribs, occasionally bifurcating; about seven of the ribs are contained in the space of an inch; they are curved sigmoidally on the sides of the shell, and form a deep sinus upon the periphery.

Fig. 1.



Nautilus elegans.—*a*, lateral view of a cast, showing the sutures and ribbing; the umbilicus is partly filled with the matrix; *b*, front view, showing the position of the siphuncle. Drawn from Sowerby's type-specimen (No. 5671) contained in the British Museum. A little more than one-third natural size.

Remarks.—English specimens of this species are usually in a compressed and distorted condition; but there is a specimen in the British Museum Collection (No. C. 37), which is quite uncompressed and shows the characters of the species admirably—sutures, siphuncle, etc. The largest specimen we have seen measures about one foot in its greatest diameter, and in its greatest breadth about $6\frac{1}{2}$ inches.

Affinities and Differences.—*Nautilus elegans* is allied to *N. pseudo-elegans*, d'Orb., but differs from it in having a much more compressed form and finer ribbing. *N. Atlas*, Whiteaves, is a more inflated shell, and has the siphuncle near the periphery. *N. elegantoides*, d'Orb., differs from *N. elegans* in the more quadrate section of its whorls, in having the siphuncle nearer the inner (dorsal) margin and the ribs straighter on the sides of the shell and more frequently subdivided.

Horizon and Locality.—Lower Chalk. Folkestone, Kent; Ringmer and Lewes, Sussex; Ventnor, Isle of Wight; Cliffe Anstey, Wiltshire.

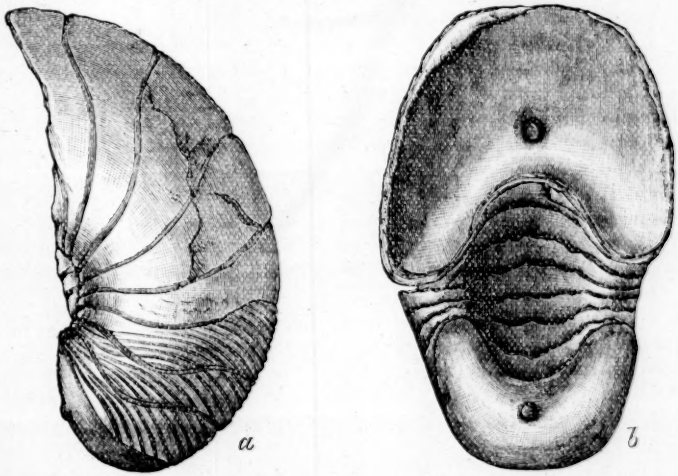
NAUTILUS ELEGANTOIDES, d'Orbigny.

1840. *Nautilus elegantoides*, d'Orbigny, Paléontologie Française, Terrains Crétacés, tome i. p. 89.

Sp. Char.—This species is briefly described by d'Orbigny (*loc. cit.*) in the following paragraph:—"Il parait donc constant, d'après les observations des géologues et d'après mes observations personelles, que le *Nautilus elegans* est spécial aux couches des craies tufau; car, tous les fragmens que j'ai recueillis dans le grès vert de la Normandie (Vaches noires), me portent à croire qu'il y existe encore une autre espèce voisine de l'*elegans*, mais bien plus étroite, et à siphon plus médian, que j'ai nominée *Nautilus elegantoides*, mais je ne la posséde pas assez complète pour la caractériser nettement."

Remarks.—As no mention is made of this species by d'Orbigny in his 'Prodrome' or elsewhere, it may be assumed that he never succeeded in obtaining such material as would have enabled him to describe the species completely. There is, however, a specimen in the British Museum (No. 37001) which possesses all the characters essential for the diagnosis of the species, which may thus be described:—Shell somewhat inflated, sides and periphery rather flattened, thus giving a squarish form to the whorls in section; widest part of the whorls in the umbilical region. Umbilicus open, of moderate size. Septa moderately distant; sutures considerably

FIG. 2.



Nautilus elegantoides.—*a*, lateral view of a very imperfect specimen, showing the form of the sutures; *b*, front view, showing the position of the siphuncle. Drawn from a specimen in the British Museum. One-third natural size.

curved backwards on the sides of the shell, and forming a conspicuous sinus on the periphery. Siphuncle considerably below the centre of the septa. Ornaments (seen only on the cast) consisting of strong, prominent, transverse ribs, which often separate into bundles of

from two to four after leaving the umbilicus, so that in the umbilical region they are much wider and coarser than in any other part of the shell. The interspaces dividing the ribs do not exceed one-half the width of the latter. The ribs are only slightly curved on the sides of the shell, but they form a conspicuous sinus on the periphery. The body-chamber is unknown.

Affinities and Differences.—This species most nearly resembles *Nautilus elegans*, J. Sow., but differs both in its general form, in the position of the siphuncle, and in the character of its ornaments.

Horizon and Locality.—Grès Vert (Upper Greensand). Honfleur (Calvados), France.

Nautilus Atlas, Whiteaves.

1840. *Nautilus elegans*, d'Orbigny, Paléontologie Française (Terrains Crétacés), tome i. p. 87, pl. xix. (*Not* of J. Sowerby.)
1850. *Nautilus elegans*, d'Orbigny, Prodrome de Paléontologie Stratigraphique, tome ii. p. 145. (*Not* of J. Sowerby.)
1853. *Nautilus elegans*, Sharpe, Description of the Fossil Remains of the Mollusca found in the Chalk of England (Mon. Pal. Soc.), pt. i. Cephalopoda, p. 12, pl. iii. fig. 3; pl. iv. fig. 1. (*Not* of J. Sowerby.)
1876. *Nautilus Atlas*, Whiteaves, Geol. Surv. of Canada, Mesozoic Fossils, vol. i. pt. i. p. 17.

Specific Characters.—Shell inflated, broadly rounded on the periphery, which makes a continuous arch with the sides and imparts a semilunate outline to the whorls when seen in section. The greatest breadth of the whorls is therefore a little above the umbilical region. Umbilicus closed. The septa are rather distant, being (type specimen) $1\frac{1}{3}$ inches apart where the height of the whorl, measured from the umbilicus to the median line of the periphery, is $3\frac{1}{2}$ inches. Siphuncle situated considerably above the centre of the septa. Test ornamented with rather strong, prominent, rounded ribs, separated from each other by interspaces equal to about half the diameter of the ribs. The latter make a broad forwardly-directed curve on the sides of the shell, and a broad and shallow sinus on the periphery. Owing to the lateral compression undergone by some specimens, this sinus appears very deep in them, but in uncompressed specimens, of which there are a few in the British Museum collection, the sinus is always shallow. The ribs leave their mark upon the cast in the form of faint plications.

Remarks.—The above description is drawn up mainly from d'Orbigny's figured type; but there is in the British Museum a fairly good example (No. C. 1027) from the same horizon and locality (Craie chloritée, Rouen) as d'Orbigny's specimen. The same Museum contains also some fairly well preserved English specimens.

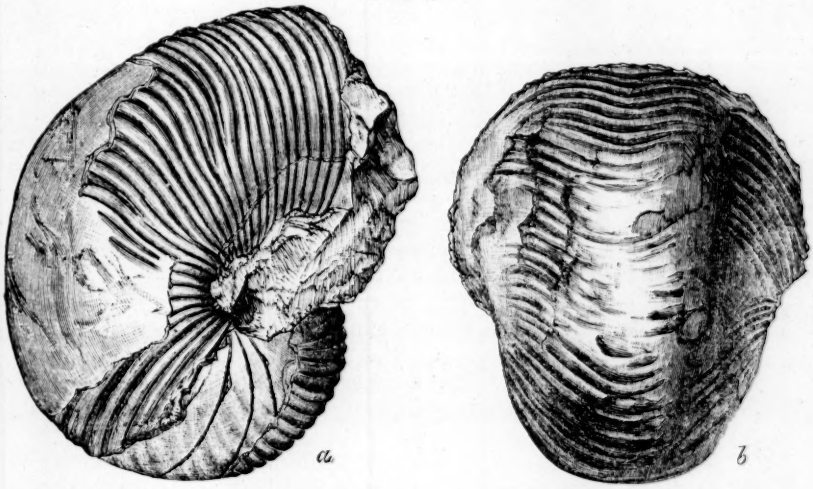
Affinities and Differences.—The inflated form of the present species, the closed umbilicus, and the position of the siphuncle (nearer the peripheral border) are characters which distinguish this species from *N. elegans*, J. Sow.

Horizon and Locality.—Lower Chalk. Dover and Burham, Kent; Lewes and Newhaven, Sussex; Cliffe Anstey and Calne, Wiltshire; Ventnor, Isle of Wight; Rouen (Calvados), France.

Nautilus pseudoelegans, d'Orbigny.

1840. *Nautilus pseudoelegans*, d'Orbigny, Paléontologie Française (Terrains Crétacés), tome i. p. 70, pl. viii., pl. ix.
1853. *Nautilus pseudoelegans*, Sharpe, Description of the Fossil Remains of Mollusca found in the Chalk of England (Mon. Pal. Soc.), pt. i. Cephalopoda, p. 13, pl. iv. figs. 2*a*, 2*b*.
1858. *Nautilus pseudoelegans*, Pillet, Description Géologique des Environs d'Aix en Savoie, p. 33, pl. vi. fig. 3.
1859. *Nautilus pseudoelegans*, Pictet et Campiche, Description des Fossiles des Environs de Sainte-Croix (Paléontologie Suisse, sér. ii. pt. i. livr. vii.), p. 123, pl. xiv. and xiv. *bis*.
?1861. *Nautilus pseudoelegans*, Blanford, Mem. Geol. Surv. of India—Palæont. Indica—I. Cretaceous Cephalopoda of Southern India, p. 33, pl. xvii. fig. 3; pl. xviii. figs. 3, 3*a*, 3*b*; pl. xix.; pl xx. figs. 1, 1*a*.
?1866. *Nautilus pseudoelegans*, Stoliczka, *ibid.* p. 210, pl. xciii. fig. 3.

Fig. 3.



Nautilus pseudoelegans.—*a*, lateral view, showing three of the septa, and the cast of the body-chamber, partly covered by the test; *b*, peripheral view, showing the curvature of the septa in the median line. Drawn from a specimen in the d'Orbigny Collection in the Museum of Natural History, Paris. About one-third natural size.[1]

Specific Characters.—Shell much inflated, very broad, with somewhat flattened sides and a very broadly rounded periphery, slightly flattened in the adult shell. Greatest width of the whorls about midway between the umbilicus and the median line of the periphery. Umbilicus small but distinct. Aperture very wide, semi-lunate, with rounded lateral margins. Septa approximate, very slightly sinuous on the sides of the shell, and forming an inconspicuous sinus on the periphery. Siphuncle situated below the centre of the septa. Test in the young shell very slightly striated transversely, but in the adult covered with very strong, regular, prominent, separate ribs or plications, which form a sigmoid curve on the sides of the shell, and

[1] A cast of this specimen is now in the British Museum.

rather a deep sinus on the periphery. The ribs bifurcate, and even trifurcate, in some places on the sides of the shell; the interspaces dividing them are about one-half the width of the ribs themselves. The ribs mark the cast with very conspicuous plications: the former become flattened by weathering, but, where well preserved, they are seen to be distinctly rounded.

Remarks.—In a letter just received by one of us, Dr. Paul Fischer makes the following interesting observations on the present species, and we gather from his remarks that there is no hope of determining with certainty the specimen selected by d'Orbigny as his type. Dr. Fischer states: "The type of *Nautilus pseudoelegans* is difficult to recognize. According to the dimensions given in the original diagnosis (diameter 240 millimètres, thickness 160 mm. Paléont. Franç p. 60) our specimens, No. 4834 D, which were sent to you, are typical.[1] Moreover, they come from the neighbourhood of Vandeuvre (Département de l'Aube), where the species was found.

"But the drawing given by d'Orbigny is faulty; first, its dimensions do not agree with the description; then the drawing being reduced to one-third the natural size, the specimen which it represents should have been at least 360 mm. in diameter; besides, the ornaments are wanting in the drawing on a great part of the last whorl. . . . .

"Consider then the figure by d'Orbigny as only approximate. D'Orbigny has restored a great many of his plates, for which, in my opinion, he is very much to blame. . . . .

"In the d'Orbigny collection no specimen is specially marked as the type. But d'Archaic (Hist. du progrès de la géologie, vol. iv. p. 295) quotes *N. pseudoelegans*, and he has given to the Museum a specimen marked *type*. This specimen is small (greatest diameter 150 mm.), and agrees neither with the figure nor with the dimensions given in d'Orbigny's original description.

"Perhaps the true type was contained in the collection of the geologist, Clément Mullet, who showed d'Orbigny over the locality where *N. pseudoelegans* abounds?"

The majority of the British examples of this species which we have seen are very much crushed. There is, however, in the British Museum collection a large natural cast (No. C 1368) which in all probability belongs to this species. It is from the Lower Greensand and measures 1 foot 2 inches in its greatest diameter and about 8 inches in width. The septa are rather distant from each other, being about two inches apart on the sides of the shell; the sutures are slightly flexuous upon the sides and also upon the periphery. The test is not preserved, but the robust form of this specimen and its general appearance ally it to *N. pseudoelegans*.

Affinities and Differences.—These will be found detailed on p. 546.

Horizon and Locality.—Lower Greensand. Maidstone and Sandgate, Kent.

[1] Two specimens were sent, both numbered 4834 D; the larger one is represented in Fig. 3.

IV.—On Some Fossils from Central Africa.

By Professor T. Rupert Jones, F.R.S., F.G.S., etc.

IN Professor Henry Drummond's "Tropical Africa," 8vo. London, 1888, pp. 183–199 are occupied with an interesting "Geological Sketch" of the country between the Zambesi River (about 18° S. Lat.) and the Tanganyika plateau (about 3° S. Lat.), his own observations having been made along a route from Kilimane on the coast, to the Shiré, and up that river, by Lake Shirwa and Lake Nyassa, to Karonga (or Karonga's village) on the north west shore near the end of the lake; and thence through the Uchungu district, for about 70 miles, in a part of the Tanganyika plateau. This region, like most of the country bordering the lake, is composed of "granite and gneiss." There are igneous rocks on the north-eastern shore at the lake's head; and a stretch of sedimentary strata for about twenty miles south of Karonga on the shore, and further south inland away from the lake (as indicated on the map in Prof. Drummond's book). These strata are referred to as "red and grey sandstones, fine conglomerate, limestone, shale, and coal," and are shown on the map as the same as some west of the Lake Tanganyika,—some about six degrees to the East, towards Zanzibar,—and some on and below the Zambesi, including Livingstone's coal-beds at Teté on that river.[1] Indeed these beds are correlated (at p. 185) with the series in Cape Colony and Natal known as the Karoo Formation,—at all events as having "a somewhat similar relation" to the gneissic plateau.

Coal.—At page 187, Prof. Drummond refers to a locality where coal was found some years ago by Mr. Cecil Rhodes, examined subsequently by Mr. James Stewart, and revisited by himself—namely, "on the western shore of Lake Nyassa, about 10° South Latitude." He does not report so favourably of this coal-seam as Mr. J. Stewart did in the "Proceed. R. Geograph. Soc." new series, vol. iii. 1881, p. 264. The latter observer noticed that in the valley of the Rikuru, running northward across 10° 45′ S. Lat., there is a great change from "the granite and quartz, which prevail throughout the whole country from the Murchison Cataracts on the Shiré River to Lake Tanganyika," to argillaceous rocks and shales, hard and soft, with sandstone, dipping 1 in $2\frac{1}{2}$ west and by north. Reaching the mouth of the Rikuru on Lake Nyassa, in south latitude 10° 45″ 15′, and going northward along the coast, after three miles he came to "the stream in which is the coal discovered by Mr. Rhodes. The coal lies in a clay bank tilted up at an angle of 45°, dip west. It is laid bare over only some 30 feet, and is about seven feet thick. It hardly looks as if it were in its original bed. The coal is broken and thrown about, as if it had been brought down by a landslip, and traces of clay are found in the interstices. Yet the bed is compact and full of good coal. I traced it along the hillside for some 200 yards, and found it cropping out on the surface here and there. It

[1] It is mentioned at p. 186 that the black rock on the western border of the Shiré valley, at about 17° S. lat. thought by Livingstone to be coal, probably is a "very dark diorite," which is present among the igneous rocks there.

is 500 feet above the lake-level, and about a mile and a half from the shore. I lit a good fire with it, which burned up strongly. The coal softened and threw out gas bubbles, but gave no gas jets. It caked slightly, but not so as to impede its burning. It is found in the main gorge of the Chisindiré valley," about six miles S. by E. of Mount Waller.

Visiting Mount Waller (*op. cit.* p. 265), Mr. J. Stewart found it to consist of horizontal argillaceous and sandy beds, hard and soft, for 900 feet upwards; then three bands of coarse grit, standing out along the mountain-side, form a ledge, at 1200 feet, 300 or 400 yards wide; a precipitous mass of soft shales succeeds up to 2630 feet above the lake; and then a cliff of hard compact argillaceous rock, of a dull straw-colour, in beds 10 or more feet thick, with intervening crumbling shales, reaches 3100 feet above the lake (4700 feet above sea-level).

Respecting the coal mentioned above, a footnote at p. 264 adds:—"Having submitted a specimen of this coal to Mr. Carruthers, F.R.S., Keeper of the Botanical Department, British Museum, this eminent authority has sent me the following note of the results of his examination of it:—'The coal has the appearance of a good specimen of English coal. The lines of stratification are indicated by films of . . . . mother-coal. The general form of the minute tissues are preserved in the mother-coal,—I have observed fragments of scalariform vessels; and in sections of the coal prepared for the microscope I have found the macrospores of Lycopodiaceous plants, which I cannot distinguish from similar bodies in the coal of England. After combustion only 1·8 per cent. of ash remains. I have no doubt that the specimen from Lake Nyassa is of the same age as the coal of England.'"

The hand-specimen of coal examined by Mr. Carruthers is labelled—"Coal from Mt. Waller, Lake Nyassa. Livingstonia, 22 May, 1880, Jas. Stewart." Presumably the locality is not exactly Mount Waller, but in its neighbourhood as defined above. It has an irregular oblong shape, about 6 inches long, $3\frac{1}{2}$ wide, and 3 thick; and consists of close-set parallel laminæ, some of dull, compact, cannel-like coal, and some of bright, crackled glance-coal, all irregular in their relative thicknesses, and seldom more than a quarter of an inch thick. Mother-coal (dull, fibrous, black wood-carbon) lies on an outer (uppermost) layer of the glance-coal, and probably is present at intervals in the mass.

Slices taken from the same block and prepared for the microscope were sent to Mr. R. Kidston, F.G.S., of Stirling, and he favoured me with the following letter (dated January 27, 1890):—

"I have examined carefully the two slides of Coal from near Lake Nyassa. . . . The slides sent would be classed under the descriptive term of 'Spore-Coal,' in so far as spores (macrospores) enter largely into the composition of the Nyassa specimen.

"Spore-coal generally occurs as bands of greater or less thickness in the structureless bituminous matter. Not having seen the block of coal from which the slides were taken, I cannot, of course, say

whether all the specimen had a similar composition, or whether the slides represent portions of a spore-band.

"The spores are much smaller than the macrospores usually entering into the composition of British 'Spore-coal,' but seem to be composed of an identical substance. The spores are of a reddish-amber colour. In certain parts of the slides bands of similarly coloured material occur. Although all structure is effaced in these bands, I have no doubt that they are derived from similar macrospores. The more numerous the spores in coal, the better is the quality, on account of their highly inflammable resinous quality."

Alluding to the above-mentioned coal near the mouth of the Rikuru (see p. 553), Prof. Drummond states at page 188 of his "Tropical Africa,"—"I examined this section pretty carefully, and fear I must differ slightly from Mr. Stewart in his geological and economical view of the formation. The 7-foot seam described by Stewart is certainly a deception, the seam being really composed of a series of thin beds of alternately carbonaceous and argillaceous matter, few of the layers of coal being more than an inch in thickness. With some of the most carefully selected specimens I lit a fire, but with disappointing results. Combustion was slow and without flame. Although there were what can be called *films* of really good coal here and there, the mineral, on the whole, seemed of inferior quality, and useless as a steam-coal. From the general indications of the locality I should judge that the coal existed only in limited quantity; while the position of the bed at the top of a rocky gorge renders the deposit all but inaccessible. On the whole, therefore, the Lake-Nyassa coal, so far as opened up at present, can scarcely be regarded as having any great economical importance, although the geological interest of such a mineral in this region is considerable. Sections of the coal have already been prepared for the microscope, and Mr. Carruthers, of the British Museum, has identified the macrospores of Lycopodiaceous plants, which are identical with similar organisms found in the coal-fields of England."

The specimen of coal from the neighbourhood of Mount Waller, described above, lent to Mr. Carruthers, and kindly submitted for examination, certainly seems to agree better with Mr. Stewart's description, above quoted (p. 554), than with Prof. Drummond's foregoing note on the character of his specimens. The variation of a seam, both as to structure and composition, within a limited area, may possibly account for the difference.

Fossils.—At about 60 miles N. by W. from the locality where the above-mentioned coal was obtained, Prof. Drummond discovered, at Maramura (as by label), not far from Karonga, on Lake Nyassa (and about 20 miles along the "Stevenson Road" to Lake Tanganyika), some interesting fossils, as mentioned at pages 191–195 of his book—"About a dozen miles from the north-western lake shore on the route to Tanganyika, after following the Rukuru River through a defile of granite rocks, I came, to my great surprise, upon a well-marked series of stratified beds. At a bend in the river a

fine section is exposed. They lie thrown against the granitic rocks, which here show signs of disturbance; and consist of thin beds of very fine light-grey sandstone, and blue and grey shales, with an occasional band of grey limestone. By camping on the spot for some days, and working patiently, I was rewarded with the discovery of fossils. . . . The shale naturally yields the most results, one layer especially being one mass of small *Lamellibranchiata*. . . . Vegetable remains are feebly represented by a few reeds and grasses. Fish-scales abound; but I was only able, and that after much labour, to unearth two or three imperfect specimens of the fishes themselves. These have been put into the accomplished hands of Dr. Traquair, of Edinburgh, who has been kind enough to furnish the following account of them" (in letter, dated 23rd April, 1888).

Dr. Traquair refers to and describes (pp. 193–195) six specimens of fossil Fish-remains: No. 1. *Acrolepis* (?) *Drummondi*, sp. nov. No. 2. In a piece of cream-coloured limestone, besides numerous minute scales and a fragment of a small jaw and teeth, some larger scales and bones, provisionally referred to *Acrolepis* (?) *Africanus*, sp. nov. Nos. 3 and 4. Small pieces of similar limestone with minute scales, like those mentioned above. No. 5. Grey micaceous shale with scales of another, but indeterminable, species of Fish. No. 6. The clavicle of a small Fish, in shale similar to the foregoing. All these are remains of Palæoniscid Fish.

We may remark that Fish of this kind and order are such as are found also in the great Karoo Formation of the Orange-Free-State and Cape Colony, incidentally referred to above.

Prof. Drummond writes at p. 195, with reference to the fossiliferous strata which he so fortunately met with, that they "seem to occupy a comparatively limited area, and have a very high dip in a south-easterly direction. At the spot where my observations were taken they did not extend over more than half a mile of country, but it is possible that the formation may persist for a long distance in other directions. Indeed, I traced it for some miles in the direction in which, some fifty or sixty miles off, lay the coal already described, and to which it may possibly be related."

The fossil shells collected by Professor Henry Drummond, F.R.S.E., F.G.S., etc., at Maramura, near the north-west shore of Lake Nyassa, in Central Africa, occur in a piece of greenish-grey shale, somewhat micaceous, numerous casts of small Bivalves, on two bed-planes, forming its upper and lower surfaces. On one face the casts are convex; on the other, only hollow impressions. Similar casts, in the same relative position, are inclosed in the shale; and small fragments of Fish-remains are sparsely scattered throughout. The convex casts are brown, and on them here and there dark-brown films partially represent the original shells. The concave impressions have brown-black irony stains.

The shells are oval-oblong, or suboblong, rounded at the ends unequally; the posterior being somewhat truncate, and the anterior obliquely-truncate, with an ogee curve below the umbo. Hinge-line long and straight; ventral margin slightly curved. Various

degrees of imbedment affect the visible shape; some individuals showing only a triangular outline. The surface is moderately convex, and bears rather strong concentric lines of growth.

These fossils have a general resemblance to the *Iridinæ* described and figured by D. Sharpe in the "Transact. Geol. Soc." ser. 2, vol. vii. pp. 225, 226, pl. xxviii. figs. 2–4. These were from the Karoo Formation at Graaff-Reynet in the Cape Colony. The concentric markings in the specimens from Maramura are stronger than those in fig. 4; and the shell is more oblong, more nearly vertical at the anterior end, rather fuller on the ventral, and straighter on the dorsal margin. It is not so truncate anteriorly as fig. 2, and not so square behind, nor is its umbo so near the middle of the back. The dimensions are—length 20 mm. (hinge-line 15 mm.); height 10 mm. We have nothing to add as to its generic relationship; and, as it differs specifically from *Iridina? rhomboidalis* and *I.? ovata*, it may be distinguished as *Iridina? oblonga*, sp. nov.

A portion of the piece of fossiliferous shale, with *Iridina* (?) *oblonga*, sp. nov., from Maramura, north-west of Lake Nyassa, Central Africa. Natural size.

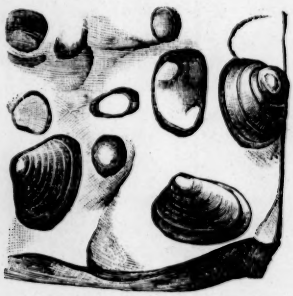
The *Iridina* may be regarded as of Mesozoic age, as well as the associated reed-like and grass-like plant-remains, and the palæoniscid Fishes; for all these are represented in the same series of strata with the Mesozoic *Dicynodon* and other Reptiles, *Cyrenæ*, plant-remains, and coal of apparently the same period. The wide extension northward of the Karoo Formation, as probably represented by these Maramura beds, is an important addition to our knowledge of African geology.

Prof. Dr. W. C. Williamson, F.R.S., informs me that he has not found in South-African coals "decided evidence of *spores*, especially *macrospores*, such as we get in so many of the British splint-coals. The nearest approaches have been in the Cyphergat, the bottom and middle Molteno, the Wynberg on the Sand River, and Slater's coal.

In each of these a vertical section of the coal exhibits numerous very thin horizontal yellow lines, not unlike what we see in our English spore-bearing coals; but I have no proof that these lines were due to spores."

Mr. E. T. Newton, F.G.S., some years ago examined microscopically a piece of compact coal from Andreas's (or Andries's) Nek, a spur of the Stormberg, sent by the late Dr. G. Grey, see Quart. Journ. Geol. Soc. vol. xxvii. 1871, p. 51; and he says that "the coal is bright and bituminous, with partings of dull material, apparently 'mother-coal,' but there are no traces of *spores*. The section shows the bituminous part as dark-brown laminæ, similar to the bright parts of Wallsend coal; but there are no spores to be distinguished. The 'mother-coal' remains black and opake in section."[1]

Corrigenda.—At page 410 (September Number of Geol. Mag.) for the woodcut and the description substitute the following:—



A portion of one of the blocks from the Kat River, Eastern Province, South Africa, showing four of the small shells (*Cyrena? neglecta*) and parts and sections of others. Natural size.

At p. 410, line 7 from bottom, for "*Cyrenæ*" (?) read "*Cyrenæ?*"

V.—The Effects Produced by Earth-movements on pre-Cambrian and Lower Palæozoic Rocks in some Sections in Wales and Shropshire.

By Henry Hicks, M.D., F.R.S., Sec.G.S.

(Read at British Association, 1890.)

In this paper I purpose giving a few examples to show the powerful influences which have been exerted by Earth-movements in producing changes in the rocks, and in obliterating the evidences of succession in some of the disturbed areas in Wales and Shropshire. For a long time past it has been well known that certain changes such as cleavage, etc., have been induced in the rocks in Wales and elsewhere by pressure, but only of late years has the magnitude of the results due to Earth-movements been

[1] See also the "Mining Journal," Decemb. 4, 1886, for a paper on the Coals of South Africa.

fully understood. The difficulties experienced by geologists who visit these areas for the first time are mainly due to their being unable or unwilling to recognize the extraordinary effects produced by these Earth-movements, and especially to the complications resulting from faults and thrusts. In these areas it commonly happens that portions of the pre-Cambrian rocks are forced in among the Lower Palæozoic rocks so as to appear either to be parts of the series or to be intruded into it. In other places it occasionally happens that not only are lower beds of the same series made to appear to overlie much newer beds, but the pre-Cambrian rocks are, in some cases, thrust over those of Palæozoic age.

The rocks in the neighbourhood of St. David's, Pembrokeshire, have suffered in a remarkable degree from the effects of Earth-movements, and some geologists who have visited that area have been led to make not only serious errors, but some very extraordinary statements, from being unable to recognize this fact.

A section across the St. David's promontory shows that after the Cambrian and Ordovician rocks had been gradually deposited over an irregular surface of pre-Cambrian rocks, great Earth-movements took place which caused the Cambrian and Ordovician rocks to be bent into great folds. These folds were broken during these movements by numerous faults, some of great magnitude. Subsequent denudation has revealed the presence, within these folds, of the pre-Cambrian rocks on which the newer rocks were deposited, and has enabled us to recognize the enormous dislocations of the strata which have taken place, and the changes induced in the rocks during the movements. Although there are evidences of several folds of Lower Palæozoic rocks, containing cores of pre-Cambrian rocks, in North Pembrokeshire, it will be sufficient to refer to the one which occurs in the promontory of St. David's, taking a line across it from St. David's Head on the N.W. to St. Bride's Bay to the S.E. of the city of St. David's. At, and near, St. David's Head, great masses of intrusive basic rocks traverse the Arenig rocks, in a direction nearly parallel with the lines of bedding, being probably portions of sheets in the form of Laccolites. These, along with the slates, have suffered from the pressure, proving that the folding took place after they were intruded into the slates. The Arenig rocks are separated from the Tremadoc rocks along this line by a thrust-fault which has diminished the thickness of the strata by about 1500 feet. Other faults in the arch-limb of this fold have repeatedly caused newer rocks to be thrust forward to hide the underlying series, and near the axis, beds at least 5000 feet apart in the succession are by that means brought into contact. On the S.E. side of the axis the Cambrian beds have been inverted and faulted so as to cause the older beds to overlie the newer, evidently by movements from N.W. to S.E.

In the pre-Cambrian core itself the Pebidian rocks are not only sheared to an enormous extent, but are also made, on the S. side, by reversed faults to appear to lie under parts of the granitoid rocks (Dimetian). This result causes the Dimetian to look in places as

if intruded into the Pebidian beds, whilst in reality it is everywhere bounded by faults, some of them of pre-Cambrian, others of post-Cambrian age. Similar effects to those witnessed at St. David's and in other areas in N. Pembrokeshire, may be seen in sections in Carnarvonshire, especially in the area between the Menai Straits and the Snowdon district. In the part of this area lying between Carnarvon and Llyn Padarn, not only are the Cambrian rocks, by reversed faults, made to appear to underlie pre-Cambrian rocks, but even Arenig beds are faulted so as to dip under both. The movements in this area have taken place mainly from S.E. to N.W. and the rocks of the Snowdonian range have been driven westward by repeated thrusts.

In a section in Shropshire, extending from the Longmynd across Caer Caradoc, Lower Palæozoic rocks are faulted on the W. side so as to appear to underlie the pre-Cambrian rocks of Caer Caradoc, whilst on the E. as the result of thrust-movements, the older beds have been hidden by much newer ones. Here the post-Ordovician movements were mainly, as in Carnarvonshire, from S.E. to N.W.

The changes which have been produced in the rocks themselves are also very marked. The granitoid rocks give evidence of having been greatly crushed by the Earth-movements in pre-Cambrian times, and in the lines of fracture secondary minerals have been freely deposited. That these secondary minerals date back to pre-Cambrian times is shown by the fact that the pebbles of these granitoid rocks in the Cambrian conglomerates contain all the evidences of the early crush with secondary minerals in the crush-lines, in addition to those of subsequent fractures and deformation by pressure after they had been entombed in the conglomerates. In some places the granitoid rocks and diorites have suffered so much from pressure that they have put on a distinctly gneissic aspect. Some of the felstones in pre-Cambrian times were crushed so that they were formed into felsitic schists, and fragments of these schists occur frequently in the Cambrian conglomerates. Various dykes in the pre-Cambrian rocks exhibit indications of having suffered greatly from mechanical pressure in pre-Cambrian times, the diabase dykes in the Dimetian being frequently cleaved so as to look almost like slates. Fragments of these and of many other cleaved and altered rocks are often found in the Cambrian conglomerates.

In the Cambrian and Ordovician rocks the evidences of pressure during subsequent Earth-movements are also abundant, and secondary minerals have been freely developed along planes of cleavage and in lines of fracture. The effects on some of these rocks near thrust-planes are well exemplified by the remarkably distorted condition of some of the fossils. In one case near St. David's an *Orthis*, which in its normal condition was about seven lines in width, was so distorted that it measured over 27 lines, and others were still further drawn out so as to be almost unrecognizable.

VI.—The Date of the High Continental Elevation of America.

By A. J. Jukes Browne, B.A., F.G.S.

THE proofs of a much greater elevation of the American continent at no very distant geological date, which have been communicated to the Geol. Mag. by Prof. J. W. Spencer[1] and Mr. W. Upham,[2] are very interesting, and Mr. Upham's suggestion that this great elevation occurred in Pliocene and early Pleistocene time is a taking one. He thinks the culmination of the uplift coincided with the Glacial period, and was to a large extent the cause of that period; if he is right, we are forced to infer that there has been a post-Glacial submergence to the extent of over 3000 feet over the whole region, including the Gulf of Mexico. There is, however, a difficulty in this supposition, to which I beg to call Mr. Upham's attention.

The raised coral-reefs of the West Indies indicate a recent upheaval of the whole Caribbean region. In the west of Cuba these reefs occur up to 1200 feet, on the testimony of Prof. Agassiz,[3] who found recent species of corals in them at that height between Havana and Matanzas, and up to 1800 feet near Baracoa on the testimony of Mr. W. O. Crosby.[4] In Guadaloupe and Barbadoes they occur up to heights of 1300 and 1100 feet respectively, while the lowest terraces consist of soft and unconsolidated coral rock containing recent species of shells in a fresh-looking condition. It is clear in fact that there has been a regional uplift of this area to the extent of at least 1300 and probably 2000 feet in Pleistocene times, and that there has been no subsequent subsidence. Moreover, this area of elevation certainly included Yucatan, which lies on the south side of the Gulf of Mexico.

Now if the whole North American continent, including a part now covered by the Gulf of Mexico, has subsided 3000 feet since the Glacial period, it is strange to find proofs of contemporaneous elevation over the whole Caribbean region with a distance of only 400 to 500 miles between them. That there should have been in such recent times a differential movement sinking the northern part of the Gulf of Mexico through 3000 feet and raising its southern shores through more than 1300 feet, is rather a large demand on our belief.

It is Mr. Upham who must face this difficulty, for Prof. Spencer was careful not to fix the exact date of the high continental period, and only speaks of its culmination "in the later Tertiary, before the Pleistocene period." Now it happens that the Caribbean region affords evidence of a great depression preceding the elevation above mentioned. Thus in Jamaica the "White Limestone" is in part of deep-water origin, it covers a very large area in the island and is regarded as being of Pliocene age. Again, the Oceanic deposits of Barbadoes seem to indicate a subsidence of at least 6,000 feet, for they rest on shallow-water deposits, and consist of consolidated oozes comparable to those which are now found at depths of

[1] May Number, p. 208. [2] November Number, p. 492.
[3] See Three Cruises of the Blake, vol. i. p. 71.
[4] Proc. Boston Nat. Hist. Soc. vol. xxii. p. 126.

1000 to 2000 fathoms. The deposits appear to be of Pliocene or early Pleistocene age, and are covered by the raised coral-reefs.

Here, then, we seem to have a series of changes corresponding to those indicated by Prof. Spencer (*loc. cit.* p. 209), and it is surely more probable that the movements in the two contiguous areas were contemporaneous than that so great a submergence in the one should correspond with a period of high elevation in the other.

There is however an objection which Mr. Upham might urge against this view, and which I may as well anticipate: it is contained in his remark that the depression "evidently took place in a late geologic period, else the channels would have become filled with sediments." But have they not been partially filled up? Dr. Spencer remarks, "The soundings show that to within comparatively short distances of their mouths, the depths of the valleys below the surface of the seas sometimes did not exceed from 1200 to 1800 feet, but that beyond there was a great increase in depth within the last few leagues." He assumes that the present slope of the floors of the valleys does not materially differ from that they possessed as terrestrial surfaces, but surely the peculiar conformation he describes may be due to the partial infilling of the valleys with sediment, for a certain distance from the shore.

Again it is possible that the surface current of the modern river creates a submarine return current, and that the action of the latter causes less sediment to be laid down over the valley area than over the plateaux on each side. Dr. Buchanan has investigated a deep depression at the mouth of the Congo, and has gone so far as to suggest that the cañon-like trough is entirely due to the action of such a current, the mud brought down by the river being spread out over tracts to the right and left, while the tract over which the main current runs is kept clear by a strong reverse current of sea-water. Thus he supposes the bottom of the trough to represent the original outline of the continental shelf and the shore slopes on each side to have been built up by deposition of material.

Without going so far as this, it does seem possible that, if a deep-cut valley was carried below the sea more rapidly than deposition could fill it up,—a submarine current might be set up which would prevent the accumulation of more than a certain amount of sediment within it. Consequently the valley might remain as an open trough for a long period of time, and its existence could not be regarded as a proof of the recent submergence of the area.

VII.—Note on Dynamic-Metamorphism.

By the Rev. Dr. Irving, B.A., F.G.S.

I HAVE elsewhere pointed out[1] the importance of the two factors —(1) the lateral force which produces the metataxic work (*quâ* cleavage), (2) the resistance offered to the movement of the constituent particles of a rock-mass in the direction of cleavage-dip (in some cases) by the dead weight of the superincumbent mass;

[1] In my "Chemical and Physical Studies in the Metamorphism of Rocks," p. 56.

the relative value of the two modifying (in the case of a deep-seated rock-mass) the whole metataxic result. Mr. Harker applies the idea in some criticisms of a paper of General MacMahon's on the "Crumpled Culm-measures of Bude" (See GEOL. MAG. April, 1890).

Suppose a case in which the two forces were equal or nearly so. As long as this condition of things continued, the rock-mass would not shear at all; it would be in the condition which Professor Heim calls one of "latent plasticity," if no lateral movement in any direction were possible. This is equivalent to *hydrostatic pressure*, as I have pointed out (*op. cit.* pp. 47, 48). Compression of the mass might result, but not shearing. Until the limit of compressibility was reached, there must be internal friction, with the necessary thermal effect. As, however, the superincumbent mass became diminished by denudation at the surface (the lateral force continuing undiminished, or even increasing, from one or more causes), shearing in the direction of cleavage-dip would set in: friction again, with its thermal effect. The *quantity* of heat generated might be very large; but its wide distribution *in time and space* would certainly give us, in most cases, insignificant results as regards *intensity* of heat (temperature). *Op. cit.* p. 54. Even the low coefficient of conductivity of rock-materials would probably suffice to make dissipation of the heat-energy keep pace with its production; so that it may be questioned if a rise of temperature of any practical value, above that at which the rock-mass was maintained by the internal heat of the earth (or the proximity of a highly-heated mass of igneous rock), would ensue. While granting therefore that under conditions of intense compression (*op. cit.* p. 55) crystallization might be facilitated for chemical bodies already formed, it may be questioned whether the distinction, drawn by Mr. Harker for deep-seated masses, is a very real one.

The same question arises in connexion with the Rev. O. Fisher's treatment of the subject in the July Number of this MAGAZINE; and it yet remains to be shown that any considerable rise of temperature (sufficient to induce *chemical* change) can be postulated, or that much, if anything, beyond those changes which I have called "metatropic" (*op. cit.*), can be accounted for by dynamic action, except in rapid movements along "shear-planes" (*op. cit.* pp. 124–126).

Mr. Fisher suggests (p. 304) that the mechanical energy of the lateral pressure is resolved in part into the "molecular form of chemical action." What can this mean? If it means that new chemical compounds are formed, it is not molecular, but *atomic* energy, which is brought into play. We surely cannot suppose (indeed, we cannot, without rolling back the development of chemical theory a few decades at least, suppose) that chemical combination is the mere addition of one element or lower compound to another; that is to say, that the configuration of the resultant compound is the mere sum of the configurations of the antecedent molecules. It is something much more complex than that. But chemical combination must generate heat, the mechanical effect of which is to expand the mass, and so tend to discount the direct effect of

pressure. The phrase "chemical action" is used, I think, a little too freely in many quarters, by people who make no pretensions to be considered chemists, as a sort of limbo to which to relegate points in petrology which they do not wish to explain.

May I add here a word of congratulation to Mr. W. M. Hutchings on his most valuable researches[1] in the fire-clays of Northumberland? He has given us a mass of facts which prove in a concrete instance, what I have contended for on general grounds (e.g. *op. cit.* pp. 53, 93[2]); and has simply "ripped up" the fallacy, *post hoc ergo propter hoc*, which underlies the assumption so often made, that the development of secondary minerals in cleaved slates and similar rocks is due to "dynamic-metamorphism"; since he has demonstrated their presence, to a large extent as the result of the ever-active laws of chemical change (aided by aqueous diffusion) in a rock which has undergone no dynamic metamorphism whatever.

NOTICES OF MEMOIRS.

I.—Scientific Results of Explorations by the U. S. Fish Commission Steamer Albatross. No. VII. Preliminary Report on the Collection of Mollusca and Brachiopoda obtained in 1887–88. By William Healey Dall, A.M. Proceedings of the National Museum, Vol. XII. No. 773.

THOUGH the greater part of this Report is devoted to a description of the species obtained, there are some introductory remarks which should not be overlooked by geologists on the conditions of life in the deep sea and on the nature of deep-sea deposits. Some of the most interesting of these notes relate to the "Archibenthal Region," as Mr. Dall terms the area which lies below the limit of Algæ and above the Abyssal Region. In this region "the action of erosion and solution .... seems less potent than in either the shallower or the deeper parts of the sea. In the shallower parts the excess of motion, in the deeps the excess of the eroding agent, may account for this." Some of the banks in these depths are formed in a way which should be noted, as perhaps accounting for the large quantities of broken shells often found in fine deposits which show little sign of currents. Mr. Dall speaks of "the habit of certain fishes, which exist in vast numbers, of frequenting certain areas where they eject the broken shells .... which they have cracked, swallowed, and cleansed of their soft tissues by digestion. .... Now, in examining critically large quantities dredged from the bottom, I have found the material from certain areas almost entirely composed of these ejectamenta."

In some 16 pp. of 'general considerations' on the Pelecypoda, Mr. Dall gives an account of the genesis of the molluscan hinge, and groups the bivalves into three orders, Anomalodesmacea, Prionodesmacea, and Teleodesmacea. It is impossible in a short abstract to

[1] *Vide* Geol. Mag. for June and July 1890.

[2] See also Appendix ii. Note T.

do justice to this classification; but the shell is recognized as modifying and in various ways being modified by the soft parts of the animal, and therefore as affording a safer basis for classification than any single anatomical character. C. R.

II.—The Geology of the Country around Ingleborough, with Parts of Wensleydale and Wharfedale. By J. R. Dakyns, R. H. Tiddeman, W. Gunn, and A. Strahan. (With Notes by C. Fox-Strangways and J. G. Goodchild.) 8vo. pp. 103. (London, 1890.) Price 2*s*.

THIS is an Explanation of Quarter-sheet 97 S.W. (50 New Series). It contains accounts of the Lower and Upper Silurian Rocks of Ingleton, Crummack and Horton-in-Ribblesdale; of the Carboniferous Limestone Series, Millstone Grit and Coal-measures; and of the Glacial and Post-Glacial deposits. Some dykes of Mica-trap penetrate the Lower Silurian rocks near Ingleton, and these intrusive rocks are described by Mr. F. Rutley.

III.—The Geology of Parts of North Lincolnshire and South Yorkshire. By W. A. E. Ussher. (Parts by C. Fox-Strangways, A. C. G. Cameron, C. Reid, and A. J. Jukes Browne.) 8vo. pp. 231. (London, 1890.) Price 2*s*.

IN this Memoir we have detailed descriptions of the strata, from the Keuper Sandstones and Marls of the Isle of Axholme, upwards to the Kimeridge Clay that underlies the Cretaceous escarpment. The several divisions of the Neocomian formation and of the Chalk are described, together with the Glacial and other superficial deposits. The Red Chalk is included at the base of the Upper Cretaceous. Long lists of fossils are given from the Jurassic rocks, and these are in part based on the work done by the Rev. J. E. Cross, of Appleby. The deposits of economic importance include the Frodingham Ironstone in the Lower Lias, and the Claxby Ironstone in the Neocomian. The Lincolnshire Limestone at Kirton-in-Lindsey yields a good hydraulic lime, which is sold as "Blue Lias Lime." A number of well-sections and borings are recorded in an Appendix.

IV.—On the Discovery of a Jurassic Fish-Fauna in the Hawkesbury Beds of New South Wales. By A. Smith Woodward.[1]

A LARGE collection of fossil fishes from the Hawkesbury-Wianamatta series of Talbralgar, New South Wales, has been forwarded to the author for examination by Messrs. C. S. Wilkinson and R. Etheridge, jun., of the Geological Survey of New South Wales. The final results will appear in a forthcoming memoir to be published by that Survey; but the investigation has already proceeded so far as to justify the announcement of the discovery of a typically Jurassic fish-fauna in Australia. Fine examples of the Palæoniscid genus *Coccolepis* occur, and this has previously been met with only in the Lower Lias of Dorsetshire, the Purbeck Beds of

[1] Abstract of paper read before Section C, British Association, Leeds, 1890.

Wiltshire, and the Lithographic Stone of Bavaria. A new fish allied to *Semionotus*, but with thinner, much imbricating scales, is also conspicuous; and another new form, allied to the Dapedioids, is remarkable from the presence of typical rhombic ganoid scales in the front half of the trunk and deeply overlapping cycloid scales over the whole of the caudal region. A *Leptolepis*-like fish, with a persistent notochord, seems to represent a third unknown generic type. Of *Leptolepis* itself there are many hundreds of individuals in a fine state of preservation. The fishes occur in a hard, ferruginous, fissile matrix, associated with well-preserved remains of plants.

V.—A Sketch of the Geology of Devonshire. By Townshend M. Hall, F.G.S. [Third edition, 1890. Reprinted from White's History, etc., of the County.]

IN the Geological Magazine for August, 1879, we briefly drew attention to the first edition of this article, which gives a capital condensed account of Devonshire Geology. In the present edition the results of recent researches are noticed, and some accounts of the Mines and Mining are added. We observe, however, that the Bovey beds are classed as Miocene, and nothing is said of Mr. Starkie Gardner's contention that the beds are of Eocene age.

VI.—Preliminary Notes on the Palæozoic Elasmobranchs, *Pleuracanthus* and *Xenacanthus*, from the Lower Permian of Bohemia. By Dr. Anton Fritsch.[1]

THE next part of the author's work, "Fauna der Gaskohle," which will probably appear before the close of the present year, is devoted to further investigations upon *Pleuracanthus* and *Xenacanthus*. Restored figures, first exhibited to the British Association at the Leeds Meeting, have been carefully prepared, being based upon the examination of no less than 200 specimens. The principal result arrived at is, that the three genera, *Orthacanthus*, *Pleuracanthus*, and *Xenacanthus*, are well characterized, and are all true Selachians. The skull is developed as a simple embryonic capsule, showing no ossifications or separate bones: it much resembles that of *Heptanchus*, and indicates that the three genera in question also belong to the Opistharthri of Gill. The branchial arches are likewise seven in number, as in *Heptanchus*. The median fins are embryonic in character, much like those of deep-sea Gadoids (e.g. *Bathygadus*). The pectoral fins are of the most primitive type in *Orthacanthus*, more advanced in *Xenacanthus*, and still more resembling the abbreviated fins of recent sharks in *Pleuracanthus*. There is no pelvic element, the basal part of the pelvic fin of each side being merely a fused mass of parallel cartilaginous rays. The claspers in the male closely resemble those of modern sharks, being formed by a modification of the dorsal or postaxial rays.[2] In the vertebral column, intercalaria are developed both in *Orthacanthus* and *Xenacanthus*.

[1] Abstract of paper read before Section C, British Association, Leeds, 1890.

[2] See figure in Zool. Anzeiger, No. 337 (1890).

REVIEWS.

I.—On the Structure and Distribution of Coral Reefs; also Geological Observations on the Volcanic Islands and Parts of South America. By Charles Darwin. [With a Critical Introduction to each Work, by Prof. John W. Judd, F.R.S.] Small 8vo. pp. 549. (Ward, Lock & Co., London, 1890.)

GEOLOGISTS are much indebted to the editor and publishers of the "Minerva Library," of which this work forms the eighteenth volume, not only for placing within the reach of all the classical writings of a pioneer like Darwin, but also for enlisting the co-operation of Prof. Judd in contributing three introductory chapters, which are invaluable to the general reader and to the student as yet on the verge of his subject. The book is practically three volumes in one, each with a special introduction; and though the type is necessarily small, it is remarkably clear, and the only evidences of cheap production are in some of the pictorial text-figures.

In the introductory remarks on Coral Reefs, Prof. Judd devotes five pages to a brief review of the circumstances under which Darwin's work was produced, and shows how the now well-known theory, propounded in that volume, at once commanded the almost universal assent of both biologists and geologists. The succeeding pages relate, with equal clearness, the most recent views on the subject, with sufficient references to literature to enable the ordinary reader to follow the somewhat extended controversy. The Professor points out that the objections to Darwin's theory have for the most part proceeded from zoologists, while those who have fully appreciated the geological aspect of the question have been the staunchest supporters of the theory of subsidence. He urges the undertaking of borings in coral reefs, adopting a suggestion of Darwin's; and he concludes by expressing the opinion that most readers will rise from the perusal of recent works on the subject fully convinced that, "while on certain points of detail it is clear that, through the want of knowledge concerning the action of marine organisms in the open ocean, Darwin was betrayed into some grave errors, yet the main foundations of his argument have not been seriously impaired by the new facts observed in the deep-sea researches, or by the severe criticism to which his theory has been subjected during the last ten years."

In a similar introduction to the work on Volcanic Islands, Prof. Judd gives an interesting *résumé* of some of the fundamental principles to the establishment of which Darwin's researches specially contributed. Von Buch's well-known theory of elevation-craters was satisfactorily disproved by the observations made in the Atlantic Islands; while the subsidence of crater-floors after eruptions, recently noted by Dana, among others, in the Sandwich Islands, was distinctly recognized in several cases. Darwin also observed the arrangement of volcanic vents along great lines of

fissure; he inaugurated the study of extinct volcanoes dissected, so to speak, by the processes of denudation; and he seems to have been the first to form clear ideas as to the true relations existing between the crystalline igneous rocks of a district and their associated lavas. In short, "while much that is new and valuable has been contributed to geological science by more recent investigations, and many changes have been made in nomenclature and other points of detail, it is interesting to find that all the chief facts described by Darwin and his friend Prof. W. H. Miller have stood the test of time and further study, and remain as a monument of the acumen and accuracy in minute observation of these pioneers in geological research."

Darwin's "Geological Observations on South America" is a work that seems to have hitherto attracted less attention than either of the foregoing. Prof. Judd, however, is inclined to believe that the researches here detailed will eventually be regarded as one of the author's chief titles to fame. It was in this volume that Darwin first emphasized the imperfection of the geological record; at the same time enunciating the important conclusion that each great geological period has exhibited a geographical distribution of the forms of animal and vegetable life, comparable to that which prevails in the existing fauna and flora. It was here, too, that uniformitarian views on the volcanic phenomena of past ages were first clearly expounded, with abundant illustrations. Finally, Darwin's study of the schists and gneisses of South America led to the earliest recognition of the intimate relationship existing between planes of foliation and thrusts during elevatory movements—thus anticipating some of the most recent conclusions deduced from researches among the metamorphosed rocks of Scotland, Norway, Saxony, and other areas.

The volume is provided with a good index of 30 pages, and will be one of the most welcome additions to a working geologist's library that has appeared for some time.

II.—Prof. W. B. Scott on the Oreodonts.

Beiträge zur Kenntniss der Oreodontidæ. By W. B. Scott. Morphol. Jahrbuch, Vol. XVI. Part 2. Illustrated. (1890.)

THIS memoir is a very valuable contribution to our knowledge of that remarkable family of North American Artiodactyle Ungulates commonly known as Oreodonts, in which the author gives in a concise form all the important features of their osteology. Judging, indeed, from the skeleton represented in the first of the plates accompanying the memoir, it may be inferred that our knowledge of the skeletal anatomy of the type-genus of the family is now practically complete, and as well known as that of existing mammals. The remarkable variations exhibited by the skulls of the different genera are admirably illustrated in the other plates; and we may especially call attention to the tendency to the development of facial vacuities in the skulls of the more specialized forms.

The typical Oreodonts or Ruminating Hogs, as they were not inaptly termed by their original describer Prof. J. Leidy, occur in the North American Miocene, from the Loup-Fork to the White River beds; but they are also represented in the Uinta or Upper Eocene, while *Helohyus* of the Bridger or Middle Eocene should perhaps be also included in the family.

Professor Scott takes as the chief character of the family the circumstance that the lower canine tooth resembles the incisors, while the form and function of the canine is assumed by the first lower premolar. The family is divided into three subfamilies as follows, viz. :—

I. Upper molars with five crescents—*Protoreodontinæ*.
II. Upper molars with four crescents.
  1. Orbits closed, a lachrymal depression, no diastema, all the premolars simpler than the molars—*Oreodontinæ*.
  2. Orbits open, no lachrymal depression, a diastema, the last premolar molariform—*Agriochœrinæ*.

The Protoreodonts are the earlier and more generalized forms, and the presence of five crescents on their upper molars suggests affinity with the *Anthracotheriidæ* and *Anoplotheriidæ*. It is indeed curious to observe that the reduction in the number of crescents on these teeth in the two more specialized subfamilies of the Oreodonts is precisely paralleled among the Anthracotheroids by the specialized Siwalik genus *Merycopotamus*, which has only four such crescents.

We hope that the learned author of this important memoir will see his way to treating other groups of extinct American mammals in the same masterly manner. R. L.

III.—Professor H. Credner on Permian Labyrinthodonts and Reptiles.

Die Stegocephalen und Saurier aus dem Rothliegenden des Plauen'schen Grundes bei Dresden. By Hermann Credner, Zeitschr. deutsch. geol Ges. Vol. XLII. (1890). Illustrated.

IN this memoir Professor Credner continues his elaborate and interesting investigations into the Labyrinthodont and Reptilian fauna of the Rothliegendes of the neighbourhood of Dresden; the species treated of in the present fasciculus being, if possible, of more than usual interest.

The first section of the memoir before us is devoted to the description of the skeleton of the Labyrinthodont genus *Hylonomus*, from which the author regards *Hyloplesion* of Fritsch as inseparable. The members of this genus comprise minute forms common to both the Old and New Worlds, the detailed anatomy of which can only be worked out by those who have the abundant material and exemplary patience which it appears to be the good fortune of the author to possess. The plates and woodcuts with which the memoir is so richly illustrated speak for themselves as to the care with which these details have been worked out. One point, however, strikes us as requiring further illustration, and the author will perhaps take

an early opportunity of expressing his views on the subject. The point to which we allude is that, according to Dr. Fritsch's definition of this group of Labyrinthodonts, the whole of the body was invested with scutes, whereas our author only mentions a ventral armour.

Of still more interest is the genus *Petrobates*, another small form presenting such a marked general resemblance to *Hylonomus* that its remains have hitherto been confused with those of that genus. It differs, however, among other characters, by the smaller skull (which does not appear to have been of a Labyrinthodont type), the longer tail, and the replacement of the Labyrinthodont ventral buckler by a system of abdominal ribs like those of the existing Rhynchocephalian genus *Sphenodon*. Its Labyrinthodont affinities are, however, displayed by the attachment of the pelvis to the vertebral column by means of only a single sacral vertebra. Since, however, this feature is exhibited by the genus *Pariasaurus*, which appears to be a reptile, although exhibiting marked Amphibian affinities, it affords no argument why *Petrobates* should not likewise be included in the Reptilia.

Dr. Credner considers that *Petrobates* connects *Hylonomus* with those Rhynchocephalian reptiles from the same deposits which he has described in earlier fasciculi of the same memoir under the name of *Cadaliosaurus* and *Palæohatteria*; and the result of his latest researches seems to establish, beyond the possibility of doubt, the intimate affinities existing between certain groups of the Labyrinthodonts and the earliest Rhynchocephalians.

The memoir concludes with the description of the skeleton of a small rhachitomous Labyrinthodont named *Discosaurus*. We would, however, point out to Dr. Credner that this name had been employed at an earlier date by Prof. Leidy for a Sauropterygian, and we would therefore suggest that he should take an early opportunity of proposing a new term.

We shall look forward with interest to further contributions by the author on the subject on which he has already thrown so much new light. R. L.

IV.—Holm, Gerhard. Om förekomsten af en Caryocrinus i Sverige. Sver. Geol. Undersökn. Ser. C. No. 115, pp. 14, 15. (Stockholm, 1890.)

Of the interesting genus *Caryocrinus* but a single species has been described, and this species, *C. ornatus*, Say, has only been found in N. America. There it occurs in the Niagara and also, according to S. A. Miller, in the Clinton group. These groups are regarded as synchronous with the British Silurian from the Wenlock Limestone to possibly as low as the Tarannon Shales.

In the present paper Dr. Holm records the find of a new species of *Caryocrinus* in the lower layers of the Leptæna-kalk on the west side of the Lissberg near Gulleråsen in Boda, a district of Dalecarlia. The Leptæna-kalk has not been traced beyond Dalecarlia, but on palæontological grounds it is referred to the Upper Ordovician. In the present instance among the associated fossils are *Cyclonema*

angulatum, *Orthis biforata*, *Athyris Portlockiana*, *Strophomena corrugatella*, *Illænus Linnarssoni*, *Favosites*, *Halysites*, *Ptychophyllum*, *Sphæronis oblonga*, *Eucystis* sp., and *Caryocystis* sp. The Cystidea are numerous and the rock is filled with stem-ossicles which Dr. Holm, after the curious custom of collectors, thinks it necessary to ascribe to Crinoidea.

Of *Caryocrinus* only one specimen has been found here. This differs from *C. ornatus* in the following points: the arms are more robust and start lower down on the radials, giving rise to a zone of protuberances on the cup, the plates of the tegmen are not quite the same, and the anus[1] lies nearer the centre.

Thus *Caryocrinus* might appear to have originated in European seas, rather than those where it subsequently flourished; but the remarkable fact that no specimens have been found in any Silurian rocks of Europe, often so prolific in Pelmatozoa, suggests another hypothesis. The genus may have developed during Ordovician times in an area that is still beneath Atlantic waters; the few individuals that ventured to Scandinavia may have found those seas unsuited to them, while others at a later date migrating towards America may have been the ancestors of those now preserved so abundantly in the State of New York. F. A. B.

V.—Revision of a Genus of Fossil Fishes — *Dapedius*. By Montagu Browne, F.G.S. Trans. Leicester Lit. and Phil. Soc. Vol. II. pp. 196–203, Pl. I.

THIS is the first instalment of a Memoir on the Liassic Ganoid *Dapedius*, in which the author proposes especially to revise the species occurring in Britain. After a preliminary review of the literature of the subject, *Dapedius dorsalis* (Agass.) is discussed in detail, the supposed species, *D. monilifer* and *D. striolatus*, being merged with this form, as presenting no satisfactory points of distinction. Dr. Traquair's restoration of the head of *Dapedius* is copied upon the plate, with the addition of some rough figures of teeth and scales, the latter inadvertently turned upside down.

VI.—A Zoological Pocket-Book. By Dr. Emil Selenka. Translated by J. R. Ainsworth Davis, B.A. (Charles Griffin & Co., 1890.)

THE plan which forms the basis of this little volume is an admirable one, and students will welcome so concise a compendium of Zoological classification. There is a laudable attempt, also, to incorporate some of the more striking results of the palæontological aspect of the subject. The brief definition of each group is accompanied by the names and some particulars of leading types; and the book is interleaved throughout for MS. notes and memoranda. We can only regret, from our point of view, that

[1] Dr. Holm calls it the mouth; but this is probably due to a too close adherence to Professor J. Hall's description, and need not be taken as a serious expression of opinion.

the work is so completely behind the times. Zoologists and Comparative Anatomists of the modern school are certainly more alive to the importance of palæontological considerations, than were their predecessors, not many years ago; but few at present attempt any systematic study even of the literature of the subject. To refer only to the Vertebrata in the volume before us, and commencing with the fishes, we may remark that *Amia* does not date back to the Cretaceous period, that *Pycnodus* was shown thirty-five years ago to be exclusively confined to the Eocene, and that *Lepidotus* and *Amblypterus* are totally unknown in the Kupferschiefer. *Proterosaurus* still remains among Lacertilian Reptiles, notwithstanding recent memoirs; and *Dicynodon* is unaccountably placed among the Dinosauria, while no mention whatever is made of the all-important Theromora. The old "order Enaliosauria" still survives; and once more the erroneous statement about the opisthocœlous character of the vertebræ of *Steneosaurus*—a permanent institution in German text-books of "Zoology"—is repeated. Among Prototherian Mammals there is no allusion to the recent discovery of true teeth, while the Jurassic types are completely omitted; and *Microlestes* is only incidentally mentioned as a kangaroo ("springing marsupial")! *Diprotodon australis* is also described as a "springing marsupial"; and it will be news to some that *Thylacoleo* is an intimate relative of the Thylacine. Among Edentates, *Glyptodon* is described as an "insectivorous form"; and, to proceed to higher groups, it may be remarked that all modern researches which have led to such striking results, especially with reference to the Ungulata and Carnivora, are ignored. The Outlines of Distribution, appended by the Translator, appear to us to be more completely up to date than any other part of the volume, and it is to be hoped, that before another edition appears, some attempt will be made to renovate the whole.

VII.—Proceedings of the Cotteswold Naturalists' Field Club for 1889–90. Vol. X. Part I. 1890.

GEOLOGY continues to occupy a large share of attention from the members of this Club. The address of the President, Mr. W. C. Lucy, is supplemented by "A Slight History of Flint Implements, with especial reference to our own and adjacent areas." There is no reliable evidence of any Palæolithic implements having been found in the district, but a number of Neolithic celts, arrow-heads, and scrapers are noted, and some of these are figured in three plates.

The Rev. F. Smithe, LL.D., furnishes some "Observations on Celestite." He remarks that this mode of spelling the name of the mineral, advocated by Dana, is now adopted in the mineralogical collection of the British Museum, in preference to Celestine; words terminating in *ine* being properly restricted to the science of Chemistry. He gives a particular account of the mineral and of its mode of occurrence, not only in Gloucestershire, but in various parts of the world. The cuttings made during the construction of the Midland and South-Western junction-railway between

Cirencester and Andoversford, are described in detail by Prof. Allen Harker and Mr. S. S. Buckman.

Prof. Harker's contribution is "On the Sections in the Forest Marble, and Great Oolite Formations, exposed by the new railway from Cirencester to Chedworth." The diagram he gives is unfortunately very much cramped, but it serves as an index to the localities mentioned. Mr. Buckman gives an account of "The Sections exposed between Andoversford and Chedworth: a comparison with similar strata upon the Banbury line." These sections are mainly in the Inferior Oolite, whose many local subdivisions are duly noted. There is also a short paper, accompanied by a plate, by Mr. E. Wethered, "On the Occurrence of Fossil Forms of the Genus *Chara* in the Middle Purbeck Strata of Lulworth, Dorset."

CORRESPONDENCE.

MR. SOMERVAIL'S CONTRIBUTIONS TO THE PETROLOGY OF THE LIZARD.

Sir,—During the last three years the Geological Magazine has been augmented by four communications from Mr. Somervail on the Petrology of the Lizard. These I have refrained from noticing (beyond making in one case a brief protest), because I wished to re-examine the whole district before writing anything more on the subject. Last summer I had the advantage of spending some time at the Lizard in company with General McMahon and the Rev. E. Hill, and we hope to bring the results of our examination before the Geological Society during the present session.

To point out the errors in observation and inaccuracies of induction in Mr. Somervail's papers would occupy far too much space in the Magazine and weary the patience of your readers. I must content myself with a general expression of opinion as to the dominant idea in each communication. First, "On a Remarkable Dyke in the Serpentine of the Lizard."[1] This is a group of separate dykes, diorite and granite, the latter containing some fragments of an older rock, and associated with a quartz-felspar vein; it is no part of the "granulitic group," as I have defined it, and gives no support to Mr. Somervail's notion of rocks of different composition segregating from one magma.

(2). "On a Breccia and an Altered Schist at Housel Cove, Lizard."[2] Here the ordinary hornblende schist has been cut by a dyke, and a fault running nearly along one surface of junction has brecciated the latter. Perhaps this dyke differs a little in composition from the types which are common at the Lizard, and there is a good example of fault breccia. As usual both rocks are rotten, but the section leads to no particular conclusions.

(3). "On the Greenstone and Associated Rocks of the Manacle Point."[3] This section is a difficult one, and there are points which

[1] Geol. Mag. 1888, Dec. III. Vol. V. p. 553.
[2] Geol. Mag. 1889, Dec. III. Vol. VI. p. 114.
[3] Geol. Mag. 1889, Dec. III. Vol. VI. p. 425.

must be left for further work. On one, however, I feel quite clear, namely, that the relations of the rocks have been completely misunderstood by Mr. Somervail.

(4). "On the Nature and Origin of the Banded Structure in the Schists and other Rocks of the Lizard District."[1] As this subject will form an important part of our paper, I content myself with observing that I can find no ground for Mr. Somervail's hypothesis of segregation, as he applies it. I question both the accuracy of his statements and the validity of his inductions. Doubtless before writing upon these difficult subjects, Mr. Somervail has trained himself by careful study both of rock-structures under the microscope, and of rock-relations in less complicated districts of other regions; but if so, I am utterly at a loss to understand his principles of interpretation and his methods of reasoning.

T. G. Bonney.

BANDED ROCKS OF THE LIZARD.

Sir,—Mr. Somervail in his paper on the Lizard rocks, published in your last issue, advances the theory of segregation to explain all the phenomena displayed by the eruptive rocks of that interesting locality, but he does not favour us with any evidence in support of his theory, and he omits to explain facts that seem incompatible with it. That such rocks as peridotite, gabbro, diorite, basaltic, and felspathic traps, and granite—rocks of well-defined species differing from each other in mineralogical contents, structure, and chemical composition (points that imply genetic differences)—should be formed on the spot by segregation from a "common magma," is sufficiently startling to the petrologist; but when we find, as competent observers have found, that these rocks cut each other in well-marked dykes following each other in a regular sequence, and that each of the principal intruders carries along with it sharp fragments of the rocks through which it has intruded, the hypothesis involves the rejection of every canon of interpretation hitherto relied on by field geologists.

When one sees diverse igneous rocks cutting across each other in a way that implies differences in their order of eruption; and when one finds the lines of demarcation between these *successive* eruptions so sharp that even thin slices examined under the microscope show a sudden transition from a rock of one chemical and mineralogical composition to another of different chemical and mineralogical composition, it seems as unreasonable to a petrologist to attribute the formation of these definite and distinct species to segregation *in situ* as it would be to attribute the jaw-bone and teeth of a well-known quadruped, found in a bed of marl, to the fortuitous segregation of the carbonate of lime.

The above-mentioned rocks not only cut each other with a definite sequence, but they preserve their individual characteristics, whether

[1] Geol. Mag. 1890, Dec. III. Vol. VII. p. 515.

they occur in veins a quarter of an inch thick, or in masses many miles wide.

Science is not advanced by the dreaming of dreams—to make progress we require evidence culminating in proof.

20, Nevern Square,
10*th November*, 1890. C. A. McMahon.

PROF. PRESTWICH, F.R.S., ON THE ELEVATION OF THE WEALD.

Sir,—I am much obliged to Prof. Prestwich for drawing attention to an expression in my "Note on the Elevation of the Weald" (Geol. Mag. September, 1890), to which I feel bound to say *peccavi*. The fact is, when that paper was written, I was ignorant of the view which the Professor had put forward so long ago as 1858 in a paper, of which he has since been good enough to send me a copy. When my 1883 paper was written, the only published statement of Prof. Prestwich's view on the geological data of the Wealden elevation, which I had before me, was that contained in the published abstract of a paper read (in my hearing) before Section C of the Brit. Assoc. at York in 1881. I am sorry I was misled by this; and the more so as it was criticized by me more than once in the 1883 paper, to which the Professor refers. A copy of that paper was sent to him at the time of its publication; but, strange to say, in the Professor's letter (which is now before me) acknowledging the receipt of it (which seems to have been lost sight of since), and offering some remarks upon some points in it, no notice was taken of my criticisms on the York paper. Was it very extraordinary that under such circumstances I was lulled into the belief that I had correctly interpreted the statements contained therein?

Prof. Prestwich will kindly allow me to refer to some remarks I ventured to make in the discussions of Parts II. and III. of his recent great paper, "On the Westleton and Mundesley Beds, etc.," the substance of which is published in the Journal of the Geological Society. These indicate, I think, sufficiently my position with regard to this question.

As to Mr. Clement Reid's paper in "Nature" in 1886 (not 1888), I did not feel the necessity of pointing out (what must be obvious to any one who looks at it), that it was a "friendly corroboration" of Prof. Prestwich's view expressed years before.

The argument for contemporaneity, "on the ground of approximate equality of altitude above the sea," I had no idea of saddling upon Prof. Prestwich in particular. I mentioned it as the only argument I had heard put forward by geologists, with whom I had discussed the question, after I suggested in the pages of the Geol. Mag. (1888) a different view to those generally held, from an examination of the principal sections "in the field."

As regards the "larger and more theoretical questions" raised in my paper, I think I have sufficiently indicated the authorities which have furnished the data from which my inferences are drawn. I am, of course, allowed to draw my own conclusion from the Professor's dignified refusal to consider them.

I can only express again my regret that I did not re-write the objectionable passage which has called forth this friendly protest from one for whom I entertain the most sincere regard; yet I think that results arrived at independently have a value, even if they are not "novel."

WELLINGTON COLLEGE, BERKS. A. IRVING.

THE ELEVATION OF THE WEALD.

SIR,—In Mr. H. W. Monckton's idea as to the "retreat of the sea" in connexion with the marine abrasion of the Weald anticlinal (see GEOL. MAG. September, 1890, p. 395), he has got a glimpse of what has been obvious enough to most students of geology for the last quarter of a century. For at least that period of time Sir Andrew Ramsay's view of the marine abrasion of the original arch of the Weald anticlinal, followed by atmospheric waste and erosion (determining the present features of the country) has been before the world in his valuable and suggestive work, "The Physical Geology and Geography of Great Britain." Mr. Monckton seems to consider the area of the *deposition* of the Wealden series to have been approximately conterminous with the present area known as the Weald. In the light of what we know of a great series of Tertiary movements in Central and Western Europe, it must be rash in the extreme to assume that the present relations of sea and land are any index of what they were in even later Mesozoic time. The statement, that, "from some undetermined period [extending at least as far back as the Purbeck, *loc. cit.*] until the formation of the Gault the south-east of England was an area of depression, *and the progress of depression was more rapid upon an east and west line which now forms the anticlinal of the Weald than either to the north or south of it*," is in flat contradiction to Prof. Green's constructive sketch of the old Wealden Estuary (see "Physical Geology," pp. 294-6). I commend this to Mr. Monckton's attention.

In his concluding paragraphs it seems he has done me the honour to reproduce partly some arguments as to the non-commensurate elevation of the Weald, which I put before the Geological Society in June last at a meeting at which he was present. These arguments are given in a more complete form in my paper in the GEOL. MAG. for September, 1890, pp. 405–6.

WELLINGTON COLLEGE, BERKS. A. IRVING.

OBITUARY.

ORAZIO SILVESTRI.

WE regret to record the death of this distinguished Sicilian Geologist and Chemist, which occurred at Catania on August 17, after much suffering. Prof. Silvestri has contributed largely to our knowledge of the workings and chemistry of Etna, and to the general geology of Sicily, while his masterly paper on the genus *Nodosaria*, and his interesting papers on the works of Soldani are of great interest and value to students of the Foraminifera.

ERRATUM.—In GEOL. MAG. November, 1890, p. 501, fourteenth line from top of page, for "These are," etc., read *There* are, etc.—EDIT. GEOL. MAG.

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